HOW 'ENJOYING A MEAL' IS SIMILAR TO 'BEGINNING A BOOK': INVESTIGATING COMPOSITIONALITY AND THE PROCESSING OF COMPLEMENT COERCION VERBS

by

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STATEMENT OF THESIS APPROVAL

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ABSTRACT

While the majority of linguistic theories concerned with semantic interpretation assume some form of compositionality—the notion that the meaning of a complex expression comes from the meanings of its constituent parts and their structural arrangement—several linguistic phenomena exist which seem to challenge (strict) compositionality on both theoretical and empirical grounds. One such phenomena, termed *complement coercion*, has gained considerable attention in psycholinguistic research in recent years, as these constructions appear not only to involve a semantic type-mismatch, but also interpretive properties which are not overtly expressed. Given recent arguments that the so-called "coercion verbs" may not constitute a homogeneous set with respect to the processing of coercion constructions, the present thesis conducts an experimental investigation into the empirical validity of this claim, reporting evidence that appears to challenge it. The findings that both aspectual and psychological verbs display evidence of complement coercion are discussed in terms of their implications for competing hypotheses.

For my family: Tracy, Madison, and Rudy.

CONTENTS

CHAPTER 1

INTRODUCTION

Interpreting a sentence involves understanding the relations that hold between the elements of which it is composed. To see how the lexical semantics of an element can affect the larger meaning of a clause, consider the sentences in (1), which, despite their surface similarity, give rise to importantly different meanings.

(1) a. The chef cooked the ravioli al dente.

b. The chef cooked the ravioli frozen.

While ostensibly alike, these sentences exhibit crucial differences that affect their interpretations. In the resultative expression in (1-a), for example, the adjective phrase is causally related to the action depicted by the verb—it is the action of cooking which causes the ravioli to become al dente. No such causal relation holds between the adjective phrase and verb in the depictive sentence in (1-b), however. Instead, the adjective phrase here describes a state holding of the object, the ravioli, at the time the action described by the verb is initiated, namely its being frozen. What these examples aim to show is that there is more to the meaning of a sentence than its structure alone.[1] While the sentences in (1) appear syntactically the same, their distinct interpretations suggest the need for investigating the interactions between the various components of grammar in order to achieve a full theory of language comprehension.

In what follows, I will explore the notion of compositionality as it applies to natural language, and the theoretical motivation behind it, reviewing some common mechanisms for composing meaning in natural language (§1.2.1). In Chapter 2, I will discuss some empirical challenges to compositionality (§2), such as the phenomena of *linguistic coercion*, focusing on a subset thereof in Chapter 3, namely *complement coercion*, where I review how

[1] For a discussion of how these types of sentences may differ syntactically, see Bruening (2016).

this apparent challenge to compositionality has been handled in formal linguistic theories (§3.1). From here, I will review the empirical and psycholinguistic evidence regarding the processing of complement coercion constructions (§3.2), before discussing the details of a pilot study aimed at exploring potential differences in the processing of different subclasses of the coercion verb set in Chapter 4. Chapter 5 concludes with a discussion of the implications these empirical findings have for competing theoretical treatments.

1.1 Pragmatic inferencing

That interlocutors utilize world knowledge in order to integrate clausal interpretations into a wider discourse context, resolve ambiguities, or identify discourse referents, is uncontroversial. This fact is well demonstrated by empirical findings of so-called "verbal illusions" wherein comprehenders readily adopt pragmatically plausible interpretations that conflict with the veridical meanings articulated by the grammar (Kracht 2007; Natsopoulos 1985; Wason & Reich 1979).

To better illustrate this point, consider, for example, the so-called "Depth-Charge" sentence, '*No head injury is too trivial to be ignored*' (Wason & Reich 1979). More often than not, this sentence receives an interpretation along the lines of 'Regardless of how unimportant it may seem, head injuries should always be treated,' despite the fact that the sentence logically paraphrases to something like 'Regardless of how unimportant it may seem, head injuries should always be ignored' (Kracht 2007).

Barton and Sanford (1993) similarly found that in response to the question '*After an aircrash where should the survivors be buried?*,' half of participants answered something to the effect of 'Near their relatives'; and to the question '*Can a man marry his widow's sister?*' only 30% of participants noticed that in order to have a widow, the man would have to be dead (Barton & Sanford 1993). Given what we know about the world, it is conceivable that these interpretations are adopted on the basis of pragmatic plausibility; that is, in light of real-world knowledge, it makes sense to ask whether a man can marry his wife's sister if his wife is dead.

Taken together, these findings suggest that linguistic input may be processed at differing depths, or in different ways, depending on the demands of the encounter—that is, we may not always pay as close attention to, or be as interpretively constrained by, the

logical form of an expression as one might suppose.[2] For some researchers, findings like these clearly constitute a challenge to the notion of compositionality (e.g., Ferreira et al. (2002)). Still, given that language users are able to exploit the linguistic properties of an utterances in order to discern subtle differences in meaning (such as those presented in (1) above), or in order to figure out the meaning of a new utterance, it stands to reason that some compositional mechanism must exist in the grammar. Whether such a mechanism distinguishes linguistic and real-world knowledge remains an open question.

1.2 Compositionality

All languages share the capacity to combine meaningful units in order to express other (more complex) meaningful units. Understanding how these meanings arise and how they relate to an expression's complexity constitutes one of the primary motivations behind the principle of compositionality—a notion dating back at least to Frege (1882), and perhaps most famously paraphrased by Barbara Partee, as in (2).

(2) "The meaning of an expression is a function of the meanings of its parts and the way they are syntactically combined" (Partee 1984:153).

As stated, the principle makes no assumptions regarding what *meaning* is, or what constitutes the *parts* of a complex expression; nor does it specify any restrictions on the means by which these component parts are to be combined. While this vagueness is desirable to some extent, as it allows for maximal generality while shielding against peremptory assertions, abandoning *all* constraints on compositionality is also dangerous as it has the effect of trivializing the notion: ultimately what we care about is not that language users can ascribe *something* to a given expression of their language compositionally, but that they can compositionally ascribe *adequate meaning* to that expression (Kracht 2007).[3] Thus, for any theory aiming at characterizing the semantic relations that do and do not hold between syntactic elements, specification of the meanings of the basic building blocks of language

[2]See Baker and Wagner (1987) for a discussion of factors that may affect critical evaluation of linguistic input.

[3]As Partee (1984:153) notes, without sufficient syntactic and lexical constraints, the principle of compositionality is effectively vacuous.

is prudent.

To complicate matters further, fixing the meaning of the principle itself is no easy task. As Szabó (2012) points out, the principle of compositionality, as stated in (2), is ambiguous in at least three ways: First, the phrase 'is a function of' could mean that the meaning of a complex expression is fully *determined by* the meanings of its parts and the way they're arranged, or alternatively, it could simply assert the existence of a function which maps the meanings of smaller constituents to that of the complex expression in which they occur (Szabó 2012:5). The differences borne out by this distinction are subtle, but important. If we assume the former interpretation of compositionality, the later is implicated, and the result is that a given sentence Γ, where the meanings of its constituents and their structural combination are held constant, will have a fixed interpretation. Alternatively, if we opt for the latter understanding of 'is a function of,' it opens the possibility that there exist different functions within the language for mapping the meanings and arrangement of Γ's constituents to the meaning of Γ. Intuitively, this alternative is somewhat weak as it would allow for the meaning of a sentence to change compositionally, even when the meanings of its constituents and the way they're combined remains the same; yet, as it is stated in (2), the principle of compositionality leaves room for either interpretation.

Another point of ambiguity regards the collective/distributive ambiguity demonstrated by the plural definite description in the phrase 'the meanings of its constituents' (Szabó 2012:7). The question here is whether this phrase should be understood as suggesting that the meaning of a complex expression is a function of the meanings that its constituents have *individually*, or alternatively, of the meanings they have *collectively*. To illustrate this point, Szabó presents the sentence '*The wealth of a country is a function of the wealth of its citizens*' (Szabó 2012:7). On the distributive reading, the sentence asserts that the wealth of a country is fixed by the wealth of its individual citizens (a somewhat implausible notion). On the other hand, the collective reading permits the wealth of a country to be understood as a function of what its citizens own collectively.

This distinction may also prove useful in understanding the classic problem of co-referring expressions, such as those in the sentence '*The morning star is the evening star*.' If we treat the principle of compositionality distributively, the sentence should be understood as synonymous with the sentence '*The morning star is the morning star*,' since

in both cases (assuming the meanings of proper names is their referent), the individual meaning of the constituents 'the morning star' and 'the evening star' is the same: Venus. However, if we think these sentences are not synonymous, we may prefer to opt for a collective understanding of compositionality, in which the collective meanings of the constituents go beyond the meanings of 'the morning star' and 'the evening star' to include some type of semantically encoded co-reference between the definite descriptions—that is, where collective meaning is comprised of the individual meanings, along with whatever meaning-relations hold between them (Szabó 2012:8). While arguments can be made in favor of both positions, what's important for our purposes is acknowledging the alternative ways in which the principle of compositionality may be construed.

A final point of ambiguity in the formulation of compositionality as presented in (2) regards determining the appropriate antecedent for the pronoun 'they' (Szabó 2012:8). Does the pronoun refer back to a complex expression's *parts* (or constituents), or to *the meanings of its parts*? If we opt for the latter understanding, we permit the possibility of two sentences with the same syntactic structure and comprised of synonymous constituents to have non-synonymous meanings—an option which the first reading does not allow. So, for example, as competent language users, we know that the 'red' in *red apple* refers to the outside of the apple, while the 'pink' in *pink grapefruit* refers to the inside of the grapefruit. Thus, it appears we have complex expressions whose constituent meanings are integrated in a way that differs from their lexical semantics, even though the mode of combination appears to be the same (Szabó 2012:9). Insofar as we concede that the knowledge of which part of the grapefruit is pink is part of linguistic knowledge, we may choose to opt for the latter reading.

Still, despite these ambiguities and vagueness, the success with which the notion of compositionality appears to capture certain intuitions about how linguistic systems work—that is, as a feature of language, compositionality appears most capable of explaining the productivity and systematicity of natural language—has led essentially every linguistic theory concerned with semantic interpretation to assume its existence in some capacity. The arguments behind this intuition are as follows:

- Competent language users are able to understand a complex expression γ that they've never before encountered (indeed, it's possible that anyone reading this thesis for

the first time has never encountered this very sentence before, and yet has no trouble comprehending it); thus, as competent language users, we must (at least implicitly) have access to knowledge that lets us determine the meaning of γ without the need for additional information.

  - A related idea regards the unbounded nature of language: there exists an infinitely large set of complex expressions which we, as beings with finite memory and finite computational power, could not possibly memorize, but nevertheless have the capacity to understand.

- Similarly, the sentences language users understand display clear and predictable patterns. If one is able to understand '*The boy is happy*' and '*The girl is sad*,' or '*blue house*' and '*yellow car*,' it stands to reason that she will also be able to understand '*The boy is sad*' and '*The girl is happy*,' or '*yellow house*' and '*blue car*.'[4]

  - Such arguments seem to apply equally well to the domain of productive morphology: language users can create novel words by combining morphemes (for example, *open* + *-able* $\rightarrow$ *openable*, as in '*That file is not openable on a Mac*'), which other speakers agree on the meaning of, suggesting that the meanings of new words are derivable from the meanings of their component parts and the way they're put together.

Yet, while the intuition is relatively clear, how strictly compositionality is thought to apply in natural language remains a source of debate. Montague (1970), for example, assumes "strong compositionality" which is held to apply in the strictest sense, preserving a homomorphic mapping between the syntactic and semantic components of the grammar (Montague 1970). On this view, the meaning of an utterances is assumed to be fully determined by the meanings of its parts and their structural arrangement. This is a very powerful view of compositionality, and implies that interpretational mechanisms operate strictly locally, attending only to the structure provided by the syntax, and accessing at most the immediate subconstituents of a syntactic node. That is, the meaning obtained at

[4]Though of course the issue is more nuanced than this, as demonstrated by the 'red apple'/'pink grapefruit' example above.

any given syntactic node is seen as a function of that node's immediate constituents and their arrangement, such that every semantic process corresponds to some process in the syntax. An illustration of this approach, as presented in Dowty (2007), is shown in (3) below for the sentence '*Fido barks*.'

(3) *meaning-of*(SYNTACTIC-COMBINATION-OF(**Fido, barks**)) =
SEMANTIC-FUNCTION-OF(*meaning-of*(**Fido**), *meaning-of*(**barks**))

(Dowty 2007:11)

This constitutes the (more or less) standard view of strong compositionality, which Jackendoff (1997) refers to as "*syntactically transparent semantic composition*" and describes as a system in which composition is driven by a syntactic structure that treats lexical items as non-decompositional entities, reflecting at most a course semantic structure (Jackendoff 1997:48-49). Such an approach can have the effect of driving semantic theories toward richer conceptions of meaning—if meaning cannot be discerned by looking deep into the structure of a complex expression, then whatever relevant semantic information a given expression carries must somehow be projected up to the level of the constituent it is a part of (cf. the Sense Enumerative Lexicon approach discussed in §3.1.1).

Alternative views of semantic interpretation, however, resist these constraints on locality, and instead assume "weak compositionality" which maintains that operations for syntactic combination may be associated with a richer semantics, but permits the possibility of non-structurally encoded semantic relations to contribute to the interpretation of a complex expression compositionally. That is, such a view of compositionality allows for purely semantic operations that don't correspond to any syntactic processes (e.g., Partee (1984); Partee & Rooth (1983)).

However, while distinguishing the strength of compositionality by the degree to which it respects the constituent structure of an expression may be taken as the standard view, it's worth noting that there are conflicting attitudes regarding what is meant by 'strong' versus 'weak' compositionality. For example, though the hypothesis sketched above makes for an elegant theory, Jackendoff (1997) and Pustejovsky (1991, 1995) argue that it cannot be sustained without the loss of valuable generalizations regarding the expressiveness of language (Jackendoff 1997:50). Instead, these authors opt for a view of strong composi-

tionality that allows for a wider range of compositional operations which take advantage of the internal structure of a lexical item's "meta-entry", or *lexical conceptual paradigm* (LCP) (Pustejovsky 1995:62) (or *lexical conceptual structure* (LCS) (Jackendoff 1997:48)), in addition to the syntactic arrangement of those elements. The notion of LCPs will be explored in more detail in §3.1.3, but briefly, these can be thought of as the level of semantic representation that incorporates properties of lexical item's meaning which can be accessed through operations such as semantic decomposition. Thus, while the Montegovian view of strong compositionality sees LCPs as opaque to syntax, the Jackendoff/Pustejovskyan view sees the interaction of LCPs and syntax as central to the (strong) composition of meaning in natural language.

Moreover, 'weak compositionality,' according to the Jackendoff/Pustejovskyan view, characterizes a system in which the only compositional mechanism available is function application, thus requiring that the number of lexical entries for a given expression be commensurate with the different contexts in which it occurs (cf., §3.1.1) (Pustejovsky 1995:59-60). In other words, on this conceptualization, a weakly compositional system is unable to generate distinct yet related senses of a lexical item from a single lexical entry. Specific implementations of each of these systems will be discussed in greater detail in Chapter 3.

Whether natural language adheres to strong or weak compositionality will be taken up further in Chapter 5, but for the time being, let it suffice to simply be aware of the fact that different formalizations ascribe compositionality to language to differing degrees, and that our evaluation of a system as strongly or weakly compositional will depend on which characterization of strong versus weak compositionality is adopted. For the sake of simplicity, I will assume the standard (Montegovian) view of compositionality moving forward, unless otherwise specified. Before looking at phenomena that appear to challenge strong compositionality (yet are consistent with weak compositionality), let us briefly outline some rules of composition which are generally uncontroversial and standardly taken to meet the requirements of strong compositionality.

1.2.1 Compositionality at work

The lexical meaning of a word in isolation is commonly viewed as being incomplete, behaving as either an active functor or a passive argument (Pustejovsky 1995:1). This

idea is reminiscent of Frege's (1884) context principle, which holds that a word only has meaning in the context of a proposition Janssen (1997). The meaning of the verb *kiss*, for example, is incomplete without both a *kisser*, and a *kissee*, as shown in (4).

(4) a. John kissed Mary.
b. *John kissed.
c. *Kissed Mary.

This context-dependent meaning can be represented by inserting variables, which act as place holders for arguments, into the word's definition: for example, *x kiss y*. As such, *kiss* behaves as a function which takes two arguments as its inputs and returns a fully saturated proposition (which can be evaluated for truth conditionality) describing the kissing of someone/something by someone/something as its output. Formally, this can be expressed using the lambda calculus, as shown in (5).

(5) $\lambda y \lambda x$.kiss(x, y)

The semantic type of *kiss*, then, is a function from individuals (labeled 'e') to truth-values (labeled 't'). According to Montague (1974), individuals and truth-values are 'fully saturated' types (i.e., they cannot predicate over arguments) and constitute the basic ontology of semantic types, from which all other types can be derived using the rule in (6).

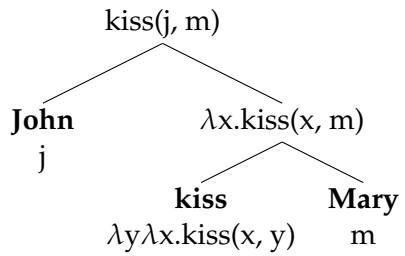
(6) If α and β are semantic types, then $< \alpha, \beta >$ is also a semantic type.

Thus, in this system, *kiss* is of the derived type $< e, < e, t >>$, denoting a function which applies to its arguments when the relationship between them is one of selection. This is achieved by the work of the basic compositional rule of *Function Application*, defined in (7) and illustrated by the tree in (8).

(7) If α is of type a and β is of type $a \rightarrow b$ then $\beta(\alpha)$ is of type b.

(Pustejovsky 2011:1406)

(8)



As shown in (8), when a function is applied to its syntactic sister, the variable bound by the lambda term is replaced by the denotation of that sister, and the lambda is removed to indicate that saturation of the predicate has occurred.

The idea behind function application is that one chunk of meaning (the predicate) has (an) empty slot(s) in its meaning, and that composition with an argument consists in that argument filling the predicate's empty slot. But some kinds of structures—specifically, modifiers—appear to require a different sort of compositional process. To illustrate this need, consider the sentences in (9).

(9) a. Mary is beautiful.

b. Mary is a woman.

Both cases in (9) can be handled using simple function application since in both sentences, '*Mary*' serves as the predicate's argument, saturating the predicate to yield a proposition which can be evaluated for truth conditionality. A problem arises, however, when we try to compose a sentence such as (10).

(10) Mary is a beautiful woman.

Here, the whole constituent '*a beautiful woman*' appears to be functioning as a predicate for the argument '*Mary*'; however, this would suggest that the two predicates in (9) are combining here to form a third predicate. Yet, nothing we've covered so far with function application provides the tools necessary for understanding this—both '*beautiful*' and '*a woman*' are of type $< e, t >$ (i.e., they both take individuals (e) as input and return truth-values (t) as their output), and thus should not be able to combine via saturation since '*beautiful*' is not the right type of argument for '*a woman*' and vice-versa; however, they do somehow combine, and their product appears again to be of type $< e, t >$.

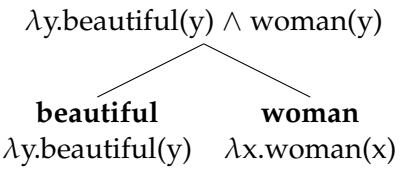
The question, then, seems to be one of how elements compose when their relationship

is *not* one of selection. That is, how do the elements '*beautiful*' and '*woman*' compose to create the constituent '*beautiful woman*' which can then be applied to '*Mary*'?

In such a case, rather than treating '*Mary*' as the missing argument of '*beautiful*' (or '*woman*'), as in the predicate-saturation approach, the compositional rule of *Predicate Modification* (defined in (11)) is employed, which functions by contributing extra meaning to an already potentially complete meaning. For the present example, application of this rule will form an intersection between 'womanness' and 'beautifulness,' allowing the elements to compose, as shown in the tree in (12).

(11) If α is a branching node, $\{\beta,\gamma\}$ is the set of α's daughters, and $[\![\beta]\!]$ and $[\![\gamma]\!]$ are both of type $< e, t >$, then: $[\![\alpha]\!] = \lambda x_e.\ [\![\beta]\!](x) \wedge [\![\gamma]\!](x)$ (Heim & Kratzer 1998)

(12)



Intersective modification can also be represented in the verbal domain using event-based semantics, as proposed by Davidson (1967), which treats events as a fundamental semantic concept and ontological primitive (Davidson 1967). The proposal is based on observed entailment relations between sentences such as those in (13), where the truth of (13-b) entails the truth of (13-a).

(13) a. Tim coughed.

b. Tim coughed loudly.

While meaning postulates might be invoked as a way of capturing these entailments (for example, a rule stating something like 'COUGH LOUDLY entails COUGH,' or more formally, $\forall x.\forall y.\text{COUGH}_2(x,y) \rightarrow \text{COUGH}_1(x)$), Davidson argues that such an approach would only serve as an ad hoc solution, and not a particularly useful one at that, since it would require a potentially infinite number of meaning postulates to account for the potentially infinitely complex pattern of entailments exemplified in language, and illustrated by his famous *butter* example, shown in (14).

(14) a. Jones buttered the toast.
b. Jones buttered the toast in the bathroom.
c. Jones buttered the toast in the bathroom with a knife.
d. Jones buttered the toast in the bathroom with a knife at midnight.
e. Jones buttered the toast slowly, deliberately, in the bathroom, with a knife, at midnight.

Contrasting this with an absence of such an entailment relation between sentences such as those presented in (15), Davidson argued for the need for a more logically complex way of expressing events than traditional treatments permitted.

(15) a. Tim coughed five minutes ago.
b. Tim coughed two minutes ago.

On his view, predicates are analyzed as containing one or more additional argument slot(s) which take existentially quantified event variables, as illustrated in (16).

(16) a. $\exists e.cough(e, tim)$
b. $\exists e.cough(e, tim) \wedge loud(e)$

Using this formalization, it is easy to see that the representation in (16-a) follows from (16-b), while no such entailment holds between the sentences in (15) since these sentences express different events.

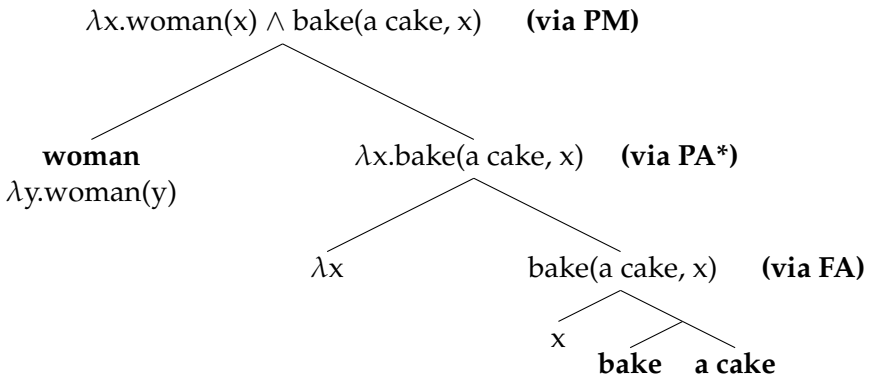
Of course, not all cases of modification should be treated as intersective (e.g., an '*alleged criminal*' is not necessarily a '*criminal*')—a fact which seems to imply a need for yet additional compositional mechanisms. Relative clause constructions provide an illustrative example of this since they behave semantically as modifiers despite the fact that their surface syntax resembles that of a sentence. Consider the example in (17).

(17) John kissed the woman who baked the cake.

For the sentence in (17) to be assigned a value of true, the individual kissed by '*John*' must both have the property of being a woman and also of baking a cake. This can be represented if the modifying relative clause '*who baked the cake*' is transformed into something of type $< e, t >$, taking '*woman*' as its argument via predicate modification (ignoring event

variables for ease of explication). Luckily, the compositional rule of *Predicate Abstraction* (PA) provides the necessary tools for achieving just such a transformation.

(18)



As shown in the tree in (18), the rule of predicate abstraction transforms the relative clause into a predicate by inserting an abstraction operator that binds a free variable within the formula. The resulting predicate is then capable of taking an individual as its argument, effectively expressing that the object denoted by that individual argument has the property of being such that the predicate resulting from abstraction applies to them (in this case, the property of having baked the cake).

While these rules of composition offer broad empirical coverage, they in no way exhaust the entire inventory of possible compositional operations. And indeed, several linguistic phenomena exist which seem to require more powerful mechanisms for compositionality. Such examples have been seen as genuine (though not necessarily insurmountable) challenges to compositionality, and will be discussed in the next chapter.

CHAPTER 2

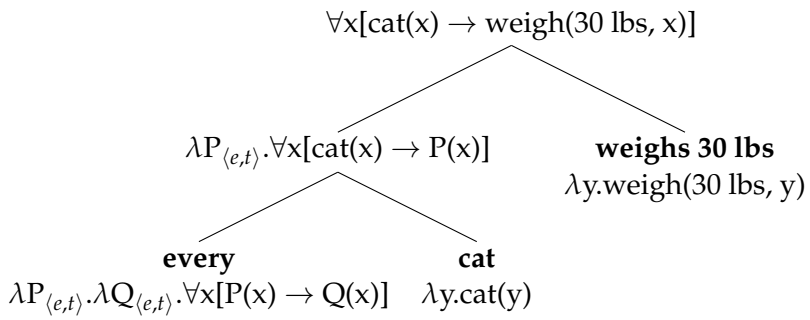
PROBLEMS FOR (STRONG) COMPOSITIONALITY

Apparent counterexamples to compositionality come in the form of complex expressions whose meaning appears to hinge on something beyond just the meanings of its constituents and their structural relation. Such cases often involve a clash between expressions of different semantic types which need to combine, but whose type-clash cannot be resolved using the compositional machinery sketched above. Nevertheless, evidence that conflicting types may still compose to yield a coherent interpretation is shown by the simple case of sentences with quantificational elements.

2.1 Composition with quantifiers

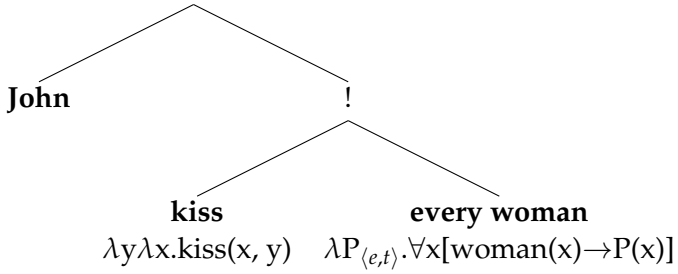
So far, we have discussed predicates as functions which take individuals as their input and return truth values as their output. Given that quantified noun-phrases (NPs) like '*every cat*' readily combine with predicates (e.g., '*Every cat purrs*'), we might be tempted to treat quantifier phrases as individuals (as with '*Fluffy purrs*'); however, such an approach seems to get the meanings of the quantified sentence wrong. Consider, for example, predications of weight: if '*every cat*' were treated as an (e-type) individual, the sentence '*Every cat weighs 25lbs*' would seem to suggest that the entity denoted by '*every cat*'—i.e., the set of all cats in the domain of discourse—weighs 25lbs, when in fact, the predication seems only to apply to individual cats within the set of cats restricted by the quantificational domain (Sauerland & von Stechow 2001). Thus, to obtain the correct interpretive predictions, we treat the quantifier phrase (QP) not as an individual input to some function, but instead as a function which selects two predications of individuals as input: one restricting the quantificational domain, and another attributing some property to the individuals within that domain. An example of this approach is presented in (1).

(1)



This approach works for quantified subjects, but unfortunately, a problem arises when it is applied to quantificational objects, as shown in (2).

(2)



As (2) illustrates, there is again a type-mismatch between the verb and its QP object. The lexical semantics of '*every*' requires its second argument to be of type $\langle e, t \rangle$, yet recall that *kiss* is of type $\langle e, \langle e, t \rangle \rangle$. In light of this issue, two alternative solutions have been put forth. The first solution is semantic in nature and involves the application of a rule for shifting the type of the QP into a 'higher type,' as illustrated in (3).

(3) $[\![Every]\!]_{basic\ type} = \lambda P_{\langle e,t \rangle}.\lambda Q_{\langle e,t \rangle}.\forall x[P(x) \rightarrow Q(x)] \rightarrow$
$[\![Every]\!]_{lifted\ type} = \lambda P_{\langle e,t \rangle}.\lambda Q_{\langle e,\langle e,t \rangle \rangle}.\forall x[P(x) \rightarrow Q(x)]$

The second solution resolves the mismatch via movement of the QP in the syntax through the operation of Quantifier Raising (QR), which effectively generates an abstract predicate of the suitable type as the object moves out of the VP (Heim & Kratzer 1998). While distinguishing between these alternatives is beyond the scope of the present thesis, the point to take from this discussion is that in either case, additional operations are needed in order to model the composition of quantified objects adequately.

2.2 More evidence for type-shifting

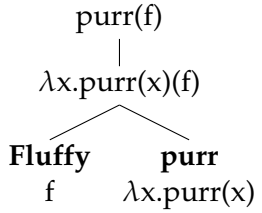
Type-shifting operations also prove useful in the domain of conjunction. Given that NPs can either be higher-order functions, such as QPs, or simple individuals, such as names or definite noun phrases, we might expect combining the two under conjunction to yield a type-mismatch and block composition; however, as the sentences in (4) illustrate, such a composition is not blocked.

(4) a. The coach and at least two players attended the meeting.

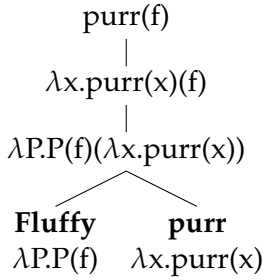
b. John and all of his friends went to the movies.

Solutions for resolving this mismatch come in two flavors. The first, following Montague (1970), treats noun phrases uniformly as higher-type predicates (otherwise known as *generalized quantifiers* (GQ)) of type $\langle\langle e,t\rangle,t\rangle$. This effectively reverses the order of function application, such that names and definite NPs, rather than being represented as individual members of sets over which certain predications hold (as is the case when predicates take individual e-type arguments as their input), under the GQ approach, are instead treated as denoting sets of sets of properties denoted by the predicates. An illustration of how this treatment (shown in (5-b)) differs from the function application approach (shown in (5-a)) is presented below for the sentence '*Fluffy purrs*'.

(5) a.



b.



The second approach is similar to the GQ approach in allowing NPs to be of the higher-type; however, this approach maintains the option for treating NPs as e-type individuals as well, and employs a semantic type-lifting operation as a last resort repair mechanism to shift the type of e-type NPs only when necessary, thereby dispensing with the homomorphic syntax-semantics mapping (and hence, strong compositionality) assumed by the Montagovian approach (Partee & Rooth 1983).

2.3 Coercion in linguistics

Another example of the interpretational system's ability to overcome apparent clashes between expressions of different semantic types is exemplified by the phenomena of 'linguistic coercion.' The term *coercion*, originally adopted from the computer sciences, has been applied to a range of linguistic phenomena that involve type-mismatches and meaning-shifts in composition (Jackendoff 1997; Moens & Steedman 1988; Pustejovsky 1991). This includes Aktionsart mismatches, such as those presented in (6).

(6) a. Tim is hiccuping.
    b. Julian was running a mile.
    c. Julian was running a mile last week. This week he is up to three.

As (6) illustrates, when the progressive auxiliary (*-ing*), which normally requires its argument to be a process or activity (i.e., ongoing), is instead combined with a non-process, such as a semelfactive (which by definition cannot be predicated as ongoing), the argument may still be coerced into an activity through iteration, as shown in (6-a). Similarly, when combined with a culminating process, the argument can again be coerced into an activity, either by "stripping off" the culmination, as it were (6-b), or through iteration, (6-c) (Bott 2010:39).

The classification of Aktionsarten was originally motivated by the observation that different verbs and verb phrases refer to different kinds of eventualities in the world. Vendler (1957, 1967), for example, proposed a four-way taxonomy for distinguishing lexical aspect, which includes STATES (characterized as non-dynamic situations, e.g., '*Eric loves Tim.*', '*Tim is happy.*'); ACTIVITIES (which involve open-ended, or non-culminating, processes describing events that are extended in time, but which are not associated with any particular conclusion or end-point. These are often combined with 'for-adverbials,' e.g., '*Jim and Derick played video games for an hour.*'); ACCOMPLISHMENTS (which involve telic processes that also extend in time but which have natural end-points or culminations that are associated with a change in the state of things. These are typically good with 'in-adverbials,' but not with 'for-adverbials,' e.g., '*Scotty wrote a song in 20 minutes.*', '*Eric built the house (in six months).*'); and ACHIEVEMENTS (which involve instantaneous changes in the state of things. These are typically good with the perfective, e.g., '*Tim has reached the*

top.', '*Eric (has) died.*') (Vendler 1957, 1967). Smith (1991) extends this typology to include a fifth lexical class: SEMELFACTIVES, which involve punctual, instantaneous events that do not result in a change in the state of things (e.g., '*Tairy Greene knocked on the door.*', '*Dr. Brule hiccuped.*') (Smith 1991).

The appeal of such a taxonomy is that it suggests that part of an utterance's meaning involves one of just a few possible aspectual or temporal profiles which can be modeled as states within a finite-state automation or transition network, allowing for Aktionsart mismatches, or 'aspectual coercions' to be represented as transitions between these states (Moens & Steedman 1988:13).

Similar phenomena have also been identified in the nominal domain where mismatches between count and mass specifications often seem to invoke coercive mechanisms (Link 1983; Pustejovsky 1991). The nouns '*water*' and '*beer*,' for example, denote substances which usually behave as mass nouns (as in '*She drinks water*'); however, when combined with the indefinite article as in (7), the interpretation of the NPs is shifted to the count domain where they are understood as objects.

(7) I'll have a water and a beer.

The distinction between substances (or "stuff") and objects (or "things") is further illustrated by the sentences in (8-a) and (8-b). As originally observed by Link (1983), given the premise '*My ring is 100% gold*,' it follows that '*my ring*' and '*the gold in my ring*' are physically identical; yet both sentences in (8-a) and (8-b) can be true despite their conflicting predications, suggesting that the "thing" denoted by '*my ring*' and the "stuff" denoted by '*the gold in my ring*' are in fact not the same (Link 1983).

(8) a. My ring isn't very old.
    b. The gold in my ring is very old.

Yet, as shown in (9) (Asher 2015:67, ex.2), in some cases, both "thing" and "stuff" entities may give rise to the same expression.

(9) a. John brought a bottle. It had a nice label./ It was yummy.
    b. John brought a bottle. It had a nice label and was yummy.
    c. John touched the bottle, which had been so yummy.

Example (9-a), for instance, offers two possible continuations for the first sentence, each of which contains the pronoun 'it.' Interestingly, it appears that the discourse referent made available by the first sentence changes depending on which continuation is chosen. In the first continuation, the pronoun refers back to the bottle as a container (object/thing), while in the second, it refers back to the bottle's contents (substance/stuff).

From the perspective of semantic type theory and selectional restrictions, '*bottle*' intuitively types as a physical object or container, which predicates like *'has a nice label'* can straightforwardly apply to. Assuming an element's type-specifications are preserved through anaphor binding, then, the pronoun in the first continuation of (9-a) is of the right type to satisfy the selectional requirements of the predicate. In the second continuation, however, the predicate '*yummy*' selects for arguments denoting potable/palatable substances—which '*bottle*' (as a physical object/container[1]) does not. Hence, in this case, the type of '*bottle*' is coerced into the type of its contents, with which '*yummy*' can then combine. Interestingly, as (9-b) and (9-c) illustrate, with coercions of this type, *both* container (default) and content (coerced) denotations for the discourse referent in the first sentence appear available.

A similar phenomena can be seen in the case of ambiguous process/result nominals such as *construction*. For example, as illustrated in (10), a sentence may make reference to either the 'process' sense of the noun (10-a) or to its 'result' sense (10-b), or even to both at the same time (10-c) (Pustejovsky 1995:94).

(10) a. The construction was arduous and tedious. (*Process*)
b. The construction is standing on the next street. (*Result*)
c. The house's construction was finished in two months. (*Process & Result*)
(Pustejovsky 1995:94)

This is not the case with other types of linguistic coercion, however, such as selectional coercion (a.k.a. "complement coercion"), where the denotation of a coerced element appears to be permanently altered. The phenomena of complement coercion constitutes the focus of the remainder of this thesis and is outlined in the next chapter, followed by a review of

[1]Assuming it's not made of chocolate or some other comestible substance.

competing proposals for how to handle the phenomena compositionally within a theory of linguistic competence.

CHAPTER 3

COMPLEMENT COERCION

Up to now, we have primarily focused the discussion of selection in terms of predicates which take individuals as their arguments; however, some predicates, such as aspectual verbs like '*begin*' and '*finish*,' as well as psychological verbs like '*enjoy*' and '*prefer*,' appear instead to select for other verb phrases (VPs), as illustrated by the sentences in (1).

(1) a. Alice began to read the book.
b. Sebastian finished writing the article.
c. Napoleon enjoyed running in the park.
d. Delilah preferred to walk to school.

In (1), the predicates '*begin*' and '*finish*' behave as functions which select for verbal descriptions of events as input, and return predications over incremental subparts (*begin* $\rightarrow$ 'initial subpart'; *finish* $\rightarrow$ 'final subpart') of those events as output. The predicates '*enjoy*' and '*prefer*' in (1) similarly select for verbal descriptions of events, and express a mapping relation between a psychological state holding of the experiencer and the action described by the complement.[1] As such, we might expect combination of these predicates with non-eventive objects to result in ungrammaticality. However, as the sentences in (2) indicate, this prediction would be false:

(2) a. Alice began the book.
b. Sebastian finished the article.
c. Halle enjoyed the hamburger.

These examples are particularly interesting as they appear to involve not only a type-mismatch between elements that need to compose, but also interpretive properties which

[1] What Nissenbaum (1985) refers to as "the emotional episode" (Pesetsky 1996:56).

are not expressed syntactically. That is, (2-a) and (2-b) seem to be interpreted along the lines of (1-a) and (1-b), respectively, which is problematic for strong compositionality since their explicit morphosyntax ([NP[V[NP]]]) does not make reference to an event, yet the only coherent interpretation demands that there be one. Comprehenders must somehow infer, add, or access information regarding what kind of activity the agent was engaged in, such that an eventive interpretation can be imposed on the (otherwise non-eventive) complement.[2] This process has been termed 'complement coercion,' and is typically viewed as a mechanism of conflict resolution on the idea that the non-eventive complement must be coerced, type-shifted, or reinterpreted in order to comply with the selective restrictions of the verb (Pustejovsky 1995:59).

Obviously, such a characterization relies on the assumption that the so-called "complement coercion verbs" do in fact select for eventive complements (an issue which will be addressed in §3.1.3). However, as Levin and Rappaport Hovav (2005) caution, there is usually more than one possible way of classifying most verbs, and "failure to classify verbs in terms of the appropriate semantic elements may give rise to spurious problems regarding the lexical semantics-syntax interface" (Levin & Rappaport Hovav 2005:12). To illustrate this point, consider the example (borrowed from Levin and Rappaport Hovav, 2005, 12-13) of unnacusativity and auxiliary selection in Italian.

Unaccusative and unergative verbs were first classified by Perlmutter (1978) using references to particular semantic classes of the verbs. Verbs such as *snore, cough, sneeze* and *yawn*, for example, which are semantically characterized as 'verbs of bodily process,' were classified by Perlmutter as unergative verbs, expected to take the auxiliary *avere* 'have,' while unnaccusative verbs were analyzed as taking the auxiliary *essere* 'be' (see Rosen, 1981, and Burzio, 1986, for similar arguments linking auxiliary selection to unnaccusativity). However, the verb *arrossire* 'blush' presented a problem for this analysis since it denotes a bodily process, yet selects for *essere* instead of *avere*. In light of this observation, McClure (1990) argued that the semantic characterization of 'verbs of bodily process' was

[2]Note that this process does not seem to be necessary when the complement is a so-called 'event nominal' (i-a), or derived nominal (i-b), as illustrated in (i).

(i) a. The man began the fight.
b. The man began fighting.

inappropriate for generalizations regarding the lexical semantics-syntax interface, and instead proposed that the rule governing auxiliary selection in Italian was sensitive to the notion of 'change of state'—activity verbs select for *avere*, while achievement verbs select for *essere* (Levin & Rappaport Hovav 2005:12-13).[3]

What cases like this remind us is that it is not always clear, a priori, which lexical semantic factors are grammatically relevant—that is, which properties of a lexical item's semantics will matter for argument realization. And indeed, many of the verbs that have been identified in the literature as participating in complement coercion phenomena have also enjoyed stimulating histories of reanalysis after challenging certain predictions made on the basis of other activity predicates.[4] With this caution in mind, let's look at the complement coercion verb set, identified in the literature by virtue of the diagnostic of predicate plus entity-denoting complement giving rise to an eventive interpretation (Pustejovsky 1991:424). These verbs fall roughly into the following three semantic classes:

- aspectual verbs: *begin, finish, continue, complete, start, end*
- psychological verbs: *endure, enjoy, tolerate, resist, prefer, survive*
- other[5] verbs: *attempt, try, expect, permit, master*

Data from psycholinguistic and neurolinguistic investigations into the processing of complement coercion sentences featuring this set of verbs have consistently shown evidence of a computational cost, or processing difficulty, emerging during the on-line reading of coercion sentences as compared with that of non-coercive sentences (Husband et al. 2011; McElree et al. 2001). Before reviewing this evidence in detail, I would first like to explore the various theoretical proposals that have been put forth in the literature to account for complement coercion phenomena, in hopes of establishing a better grasp of

[3]The difficulty of predicting syntactic behavior on the basis of semantic classification is also illustrated by ergative case assignment in Hindi for verbs of bodily/sound emission (Poornima & Koenig 2009).

[4]This especially applies to psychological verbs (cf. Baker's (1988) UTAH) but is also true of aspectual predicates (see, for example Dowty 1987, 1991).

[5]Although some of these verbs fall into the 'try' class which includes verbs denoting effort toward the achievement or culmination of some process/activity (Schuler 2005), most of the verbs in the 'try' class do not exhibit complement coercion behavior (for example, *aim, seek, strive*), and thus collectively, this group of verbs does not lend itself straightforwardly to analysis as a homogeneous set.

the computational factors that may be contributing to the comprehension of these constructions.

3.1 Theoretical treatments

Numerous attempts at accounting for complement coercion phenomena compositionally, and within a larger theory of linguistic competence, have been made. In what follows, I will provide a coarse overview of some of these formal treatments, noting some advantages and disadvantages of each.

3.1.1 Sense Enumerative Lexicon

One way of handling this apparent violation of compositionality might be to posit distinct lexical entries for the different verb senses, thus reflecting their differences in selectional behavior compositionally (see Brugman (1988) for an example of this approach). Indeed, in many linguistic frameworks, lexical ambiguity is represented by reference to distinct entries and word senses for an ambiguous expression. So, for example, we might posit a BEGIN_1 which selects for eventive complements (*John began reading*), and a BEGIN_2 which selects for entity complements (*John began the book*)[6]. However, there are several reasons for rethinking this approach as a way of rescuing strong compositionality, or even simply accounting for complement coercion phenomena.

For one, systems that appeal to a Sense Enumerative Lexicon (SEL) as a way of handling ambiguity do not distinguish lexical items that accidentally share the same form despite having distinct or unrelated meanings (homonomy), from items whose senses are logically related (e.g., the process/result senses of '*construction*' discussed in §2.3). Thus, while such a system can capture homonomy, or "accidental polysemy" (Pustejovsky 1995), it cannot capture the nature of related but distinct word senses without being supplemented with additional mechanisms, such as meaning postulates. Moreover, for an SEL approach to account for creative uses of words in novel contexts which extend their senses, it would also need to be supplemented with some kind of mechanism or system for generating new word senses. Thus, while it seems to adhere to strong compositionality insofar as respecting the constituent structure of a given sentence, it is only weakly compositional in

[6]Though it is not clear, at least to me, what the "non-eventive" meaning of '*John began the book*' would be.

the Jackendoff/Pustejovkyan sense, since it requires as many distinct representations for a word as there are linguistic contexts that it appears in, missing generalizations about how different word sense might be related, and only capturing the expressiveness of language in a post-hoc manner (Pustejovsky 2011:1404). Indeed, given the pervasiveness of polysemy in natural language, it's not difficult to imagine how unwieldy certain computations could become in an SEL system (e.g., combining two polysemous expressions, each with n number of different senses, would result in $n \times n$ possible meanings), running us into a similar problem as employing meaning postulates to account for (potentially infinitely complex) entailment relations between eventualities—an undesirable state for a computationally tractable system.

SEL approaches to lexical ambiguity also leave us in an undesirable state of circularity with regard to interpretation, since understanding the meaning of a complex expression would then entail first knowing which sense of a given word is in play—the determination of which may itself depend on understanding the meaning of the larger expression in which it occurs. Finally, this type of approach has also been criticized for its failure to account for the fact that in most (if not all) cases of complement coercion, it seems to be the object converting its sense in order to satisfy the verb, not the other way around (Pustejovsky 2011:1404). Consider the examples in (3), (borrowed from Pustejovsky 1995, 88), where the most natural interpretations for the verb 'enjoy' seem to be constrained by properties commonly associated with the NP complements.

(3) a. Mary enjoyed the movie last night. (watching)
b. John enjoys his morning coffee. (drinking)
c. Bill enjoyed Steven King's last book. (reading) (Pustejovsky 1995:88)

While there may be numerous ways of enjoying something, the interpretations elicited by these examples seem to be parameterized by information related to the particular complements (e.g., '*watching* a movie,' '*drinking* coffee,' and '*reading* a book'). Still, some theorists argue that while understanding the particular event the agent in these sentences is engaged in may depend on our knowledge of activities commonly associated with the NP complements, it does not necessarily follow that this knowledge is contained within our lexical representations of those NPs, and instead may only be determined at an extra-

linguistic level of processing due to pragmatic inferences. Examples of such theories will be examined in what follows.

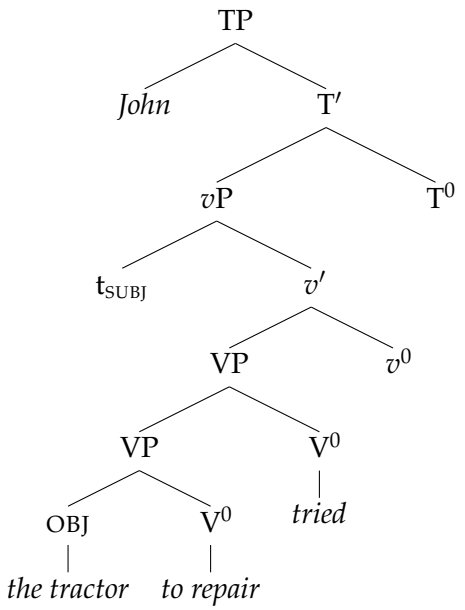
3.1.2 Structural gap

In light of the intimate connection between coerced interpretations and a verb's selectional force, we might be tempted to seek out a syntactic explanation for complement coercion phenomena—and indeed, such proposals have been made. For example, de Almeida and Dwivedi (2004, 2008) utilize the notion of syntactically active "null" elements (Chomsky 1981), arguing that coercion effects result from structural gaps in the coercing predicates, which license pragmatic inferences. The proposal extends Susi Wurmbrand's (2001, 2004) treatment of German 'restructuring verbs' to account for English complement coercion phenomena, based on an observed overlap between the verbs in the set of English "coercion verbs" and German restructuring verbs, which include *try* and *begin*.[7] On Wurmbrand's account, German restructuring predicates involve complex verbal structures, as illustrated in (4), which have an extra VP that lacks both tense and a complementizer projection, as illustrated by the tree in (4-b).

(4) a. weil Hans den Traktor zu reparieren versuchte
since John the tractor-ACC to repair tried
'since John tried to repair the tractor'

[7] Crucially, not all German restructuring predicates participate in English complement coercion phenomena (Wurmbrand 2004).

b.



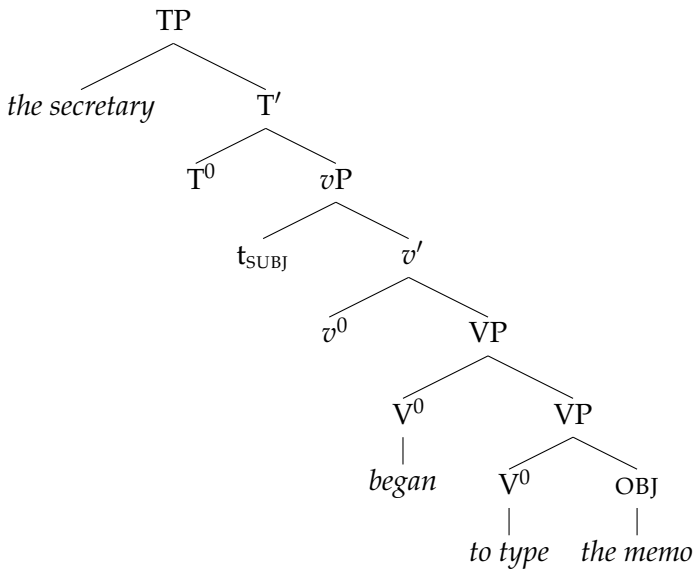
(de Almeida & Dwivedi 2008:314; from Wurmbrand, 2001, p.17)

Applying this treatment to English, de Almeida and Dwivedi argue that (5-a) is structurally simpler than (5-b), which on their treatment has a structure analogous to (5-c), containing an extra VP with an empty verbal head (de Almeida & Dwivedi 2008:313).

(5) a. The secretary typed the memo.
b. The secretary began the memo.
c. The secretary began [$_{VP}$[$_{V^0}$ **e**][$_{NP}$ the memo]]

The additional structure attributed to this class of verbs is also taken to account for their ability to select VP complements. For example, the sentence '*The secretary began to type the memo*' has the same structure as its coercive counterpart in (5-c), except that in this case, the extra verbal projection contains the infinitival head '*to type*,' as shown in the tree in (6):

(6)



(de Almeida & Dwivedi 2008:315)

On this view, the only information encoded in a lexical item is its denotation. Thus, when an overt VP complement is not selected (i.e., the environment for complement coercion), interpretation of the specific activity in question is left open to pragmatic inferencing, and is not thought to be contained in our semantic representation of the sentence (de Almeida & Dwivedi 2008:323). This has the effect of maintaining classic compositionality which assumes no need for positing extra-syntactic processes.

Yet, while this account may be appealing from the standpoint of classic compositionality, and insofar as it attempts to offer a more principled reason for treating the so-called "coercion verbs" as a homogeneous set, it appears to make the wrong predictions in several cases. For example, as argued by Pylkkänen and McElree (2006), who consider a very similar VP-insertion approach, if coercion verbs in fact have the structure in (5-c), then VP-modifiers should have two available attachment sites; however, as the examples in (7) show, only the higher position (7-a) is available for coercion constructions.

(7) a. We finished eating the meal slowly.
b. We finished the meal slowly.
c. I started cutting a loaf of bread with a knife.
d. #I started a loaf of bread with a knife.

(Pylkkänen & McElree 2006:34)

In the fully saturated VP examples in (7-a) and (7-c), both VP positions are available for modification. For example, (7-a) is true in the event of a slow meal, or 'eating a meal slowly,' coming to an end quickly, and similarly, (7-c) is true if an event of cutting the loaf of bread with a knife was initiated. In the case of (7-b) and (7-d), however, which supposedly contain an empty verbal head, only the higher VP is available for modification. In other words, (7-b) is false if a slow meal comes to an end quickly ('the meal slowly' cannot be a constituent), and (7-d) is false if an event of cutting a loaf of bread with a knife was initiated—the knife must be an instrument of the initiation (Pylkkänen & McElree 2006:34).[8]

Similarly, assuming the structure in (5-c), we cannot explain why these purported restructuring verbs display different behavior with respect to passivization when they express an overt VP complement compared to when they contain only an empty V head (Pylkkänen & McElree 2006:35). For example, as shown in (8), when no overt VP complement is expressed (i.e., in the coercion environment), passivization is grammatical (8-a). However, when an overt VP complement is present, passivization seems to be blocked, as shown in (8-b).

(8) a. The article was finished by the editor.
b. *The article was finished to be read/reading by the editor.

Maintaining this account, then, seems to amount to positing extra structure which behaves as if it is not present in certain environments. Given these obvious deficiencies, the Structural-Gap hypothesis appears less than adequate as a way of account for English complement coercion phenomena. In the subsections to follow, we will consider how more semantically-focused treatments of complement coercion fare.

3.1.3 Coercion as type-shifting

By far the most common way of handling complement coercion phenomena has been to adopt semantic mechanisms for shifting the meaning of the entity-denoting NP into an eventive one. For the purposes of this discussion, I will focus on two slightly different

[8]While it is theoretically possible that phonologically null verbal heads cannot be modified (at least in English), the authors reach the opposite conclusion, arguing that both positions should be available for modification (de Almeida & Dwivedi 2008:317).

versions of the type-shifting approach: Pustejovsky's (1991, 1995) "Generative Lexicon" approach, and Jackendoff's (1997) "Enriched Composition" approach.

3.1.3.1 Generative Lexicon

On the Generative Lexicon (GL) approach, complement (or "type") coercion is defined as "[a] semantic operation that converts an argument to the type that is expected by a function, where it would otherwise result in a type error" (Pustejovsky 1991:425). This approach assumes that coercion is ubiquitous in natural language, and embraces a relatively rich typology for modeling different kinds of linguistic coercions compositionally (Pustejovsky 1995, 1991). On this view, lexical representations are seen as highly structured entities that are minimally decomposed into an Argument structure, an Event structure, a Qualia structure, and an Inheritance structure (Pustejovsky 1995:4).

The Inheritance structure situates a lexical item's type within a type lattice, where entailments between types (for example LIQUID $\rightarrow$ PHYSICAL) are represented, allowing higher types to be inherited through the operation of subtyping, described below (Pustejovsky 1995:63). The Argument structure refines the traditional argument/adjunct distinction, distinguishing the following four types of arguments for lexical items (Pustejovsky 1995:65):

- True arguments:[9] which are syntactically realized (e.g., '*John arrived late*').
- Default arguments:[10] which are not necessarily expressed syntactically, but which are part of the logical expression of the sentence (e.g., '*John built the house (out of bricks)*').
- Shadow arguments: which are semantically incorporated into the logical expression of the lexical item, but can only be expressed syntactically via operations of subtyp-

[9]This is the domain generally covered by Chomsky's (1981) Theta-criterion.

[10]Default arguments may be expressed via a prepositional phrase as in (i-a), or as a phrase incorporated into a true argument, as in (i-b). When this happens, the material is able to be expressed as a shadow argument, as in (i-c).

(i) a. Mary built a house with wood.
b. Mary built a wooden house.
c. Mary built a wooden house out of pine. (Pustejovsky 1995:65)

ing or discourse specification (e.g., '*Mary buttered her toast with an expensive butter / *with butter*').

- True Adjuncts: which may modify the logical expression but are not necessarily part of the situational interpretation, nor tied to any particular item's semantic representation (e.g., '*Mary visited the park on Tuesday*').

The Event structure extends the Davidsonian and Vendlerian approaches discussed above, expressing events and their types as well as ordering relations over them, and specifying which part of an event (e.g., process, state, culmination) a given lexical item is focusing (Pustejovsky 1995:73). In this way, the Event structure, along with the Inheritance and Argument structures, can be seen as parameters which constrain the more centrally defined semantics of a lexical item, as presented in its Qualia structure (Pustejovsky 1995:68).

It is the Qualia structure which provides the lexical item's "relational force," and comprises information relating to a word's deeper conceptual associations (Pustejovsky 1995:76). These Qualia structures may contain, for example, information about a word's *formal* (taxonomic), *constitutive* (part-of or made-of relation), *telic* (used-for or functions-as relation), or *agentive* (origin, created-by relation) properties (Pustejovsky 1991). During the course of composition, information contained in a lexical item's Qualia structure may be accessed, exploited, or augmented by virtue of four different compositional mechanisms (parameterized by the Argument, Event, and Inheritance structures):

1. *Pure selection* or *type matching* applies when the type needed by a function is directly fulfilled by the type of its argument (e.g., in the sentence '*The rock fell.*' "fall" is of type PHYS$\rightarrow t$, and "the rock" is of type PHYS, so no type adjustment is needed before function application can straightforwardly apply, yielding *fall(the-rock)* (Pustejovsky 2011:1412)).

2. *Accommodation* or *subtyping* applies when the type needed by a function is inherited by the argument (e.g., in the sentence '*Some water fell on the floor*,' "water" is of type LIQUID, which is a subtype of PHYS; here, accommodation subtyping can apply, shifting the type of "water" to PHYS, and allowing function application to apply as before, yielding *fall(some-water)* (Pustejovsky 2011:1414)).

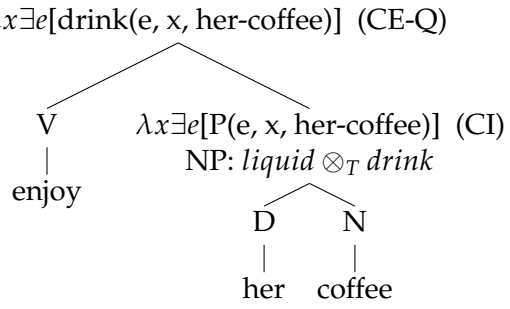
3. *Type coercion* applies when the type needed by a function is not directly satisfied by the type of its argument, nor inherited via a subtype relation, but is instead imposed on the argument by one of two strategies:

   (a) either via *introduction* (CI), where the argument is "wrapped" with the type needed by the function (e.g., in the sentence '*The water spoiled*,' "spoil" is an artifactual predicate of type PHYS $\otimes_T$[11] $\tau \rightarrow$ t, while "water," which is of type LIQUID, is from the subdomain of natural entities (e_N). In this case, subtyping must first apply, converting the type of "water" into the type PHYS. Coercion by introduction can then apply to introduce a telic (τ) value for "water," giving it the type PHYS $\otimes_T \tau$, at which point function application can apply, yielding *spoil(the-water)* (Pustejovsky 2011:1417)).

   (b) or via *exploitation* (CE-Q), where the function is satisfied by taking part of the arguments type (via its Qualia structure). Since this is the relevant operation for complement coercion, a full derivation is provided below.

To help illustrate how composition might proceed in the case of complement coercions, consider the derivation[12] in (9) for the sentence '*Alice enjoyed her coffee*':

(9)



When '*enjoy*,' which in this system is of type EVENT $\rightarrow$ ($e_N \rightarrow$ t), attempts to compose with '*her coffee*,' which is of type LIQUID $\otimes_T$ DRINK (via GQ type shifting, where $\otimes_T$ indicates a complex type with a telic force), a type-mismatch occurs. This type-mismatch then triggers the repair mechanism of *Coercion by Introduction* which applies the type EVENT to

[11] Where $\otimes$ indicates a type-constructing operator which adds a qualia relation to the lexical head's type. Here, the subscript T indicates that it is the TELIC qualia role being added (Pustejovsky 2011:1408).

[12] Adapted from Pustejovsky, 2011, p.1422, example 55. For example derivations of other types of coercion, see Pustejovsky (2011).

LIQUID $\otimes_T$ DRINK, shifting '*her coffee*' into an event. At this point, *Coercion by Exploitation* applies, extracting the value 'drink' from the object's qualia structure and binding it to the predicate P. Finally, the constituent is of the right type for standard function application to apply, saturating '*enjoy*' and yielding λy.enjoy(y, λx$\exists$e.drink(e, x, her-coffee)) (Pustejovsky 2011:1422).

Thus, in this system, the qualia structure encodes properties associated with nouns and NPs, and in turn provides coercing verbs with the information necessary for construing the contextualized eventive interpretations characteristic of complement coercion sentences. This has the effect of reducing the size of the lexicon (as compared to an SEL approach) by conflating distinct but related word senses into a single lexical entry, allowing for generalizations about related word senses to be captured in a way that having each sense lexically specified does not (Pustejovsky 1995:62). This also has the effect of allowing arguments in subject position, in addition to those in complement position, to contribute to the interpretation of coerced expressions. For example, differences in the contextualized meanings of the verb 'read' in (10) below can be explained in terms of different qualia roles being exploited—the *telic* role in (10-a) and the *agentive* role in (10-b).

(10) a. The student finished the book. (reading)
b. The author finished the book. (writing)

Yet, while this approach is has the advantage of being able to model a wide range of different linguistic coercions compositionally, as well as being able to account for distinct but related senses of a given lexical item, the system is highly flexible and may be at risk of overgenerating unattested structures (for instance, '**John began the contact lenses*' may be generated if the telic role of the NP—something like 'wearing'—is exploited). Similarly, while this system attempts to specify the activity relating the verb and its argument(s) by positing more richly structured lexical representations, it offers no obvious way of distinguishing analytic information (i.e., information true by virtue of linguistic content) from synthetic information (i.e., general world knowledge or private/shared beliefs) in order to discern what information is contained in a lexical entry.

3.1.3.2 Enriched Composition

Unlike the GL approach, which is compatible with a theory that assumes derivations proceed incrementally, Jackendoff's (1997) *Enriched Composition* approach assumes derivations proceed in parallel, via independent rule systems at the various interfaces. On this account, the lexicon is part of the interface between the syntactic and the conceptual (or semantic) components of the grammar, and lexical items are themselves seen as the correspondence rules (Jackendoff 1997:89). Thus in cases where an argument's type matches the selectional requirements of its functor, the elements can be brought together via normal function application. However, when a mismatch occurs, as with cases of complement coercion, an operator is inserted into the representation as an intervener, which assigns an activity interpretation to the entity NP, allowing it to be interpreted as "an unspecified activity involving NP" (Jackendoff 1997:61). As Culicover and Jackedoff (2005) put it, "coercion is said to mediate between a function and an incompatible argument the way an adapter mediates between and incompatible socket and plug" (as cited in Audring & Booij (2016:627)). In cases of complement coercion, the type-mismatch occurring between the eventive verb and its entity NP complement triggers a semantic process of enrichment where the utterance is augmented by the function (informally) presented in (11).

(11) Interpret NP as $[_{Activity}F(\text{NP})]$

The specific activity described by the sentence is initially left open, and determined (at a second or later stage of interpretation) by semantic and pragmatic information associated with the object NP, the verb's subject, and possibly, discourse context. This approach is intuitively appealing, as the unspecified nature of the activity contributed by application of the enrichment function nicely reflects the absence of an overt activity expressed in the surface syntax of coercion constructions. However, it is also somewhat difficult to evaluate by virtue of the fact that the details of specification are left vague, making it difficult to derive clear predictions about how language users actually compute coerced interpretations.

While both type-shifting theories discussed in this section view semantic objects as highly structured, they differ with regard to the type of information assumed to be incorporated into lexical representation, as well as in the mechanisms employed for generat-

ing the meaning of a complex expression. On Pustejovsky's *Generative Lexicon* approach, for example, lexical representations contain only linguistic information, independent of common-sense knowledge and pragmatic inferencing (Pustejovsky 1995:233). This information can then be accessed by semantic and syntactic mechanisms for generating meaning. As such, the GL theory is an analytic one, purporting to distinguish analytic and synthetic information at the level of linguistic representations. However, as noted in the previous subsection, the theory has been criticized for the lack of success with which it appears to be able to achieve this distinction.

On Jackendoff's Enriched Composition approach, on the other hand, lexical representations include all the richness and interconnections of human knowledge (sometimes called encyclopedic knowledge and sometimes pragmatic), which his coercion mechanism can make use of during the construction of an interpretation (Jackendoff 1997:64). Thus, our selection of one type-shifting approach over the other may boil down to theoretical considerations about the structure of lexical entries.

An additional challenge faced by both type-shifting accounts of complement coercion sketched in this section regards the fact that they rely on the assumption that verbs like *begin* and *enjoy* require events as their internal arguments, and that NPs which are not inherently eventive must be coerced, or type-shifted, in order to comply. However, as the sentences in (12) illustrate, coercion verbs in combination with entity-denoting NPs do not always give rise to an eventive interpretation.

(12) a. This is the famous perch that officially begins the Appalachian Trail.
b. A little porcelain pot finished the row.
c. A thunderstorm started the morning. (Piñango & Deo 2016:569)

These examples, characterized in the literature as representing the so-called "constitutive" reading of aspectual predicates, illustrate that verbs like *begin* and *finish* do not obligatorily select for events (Lai et al. 2016, 2014; Piñango & Deo 2016). In (12-a), for example, 'begins the Appalachian Trail' does not mean that some activity associated with the Appalachian Trail has been initiated, but simply that the 'famous perch' is situated at the beginning, or entrance of the trail. Similarly, in (12-b), the subject 'a little porcelain pot' is understood as being positioned at the end of a row; it does not assert the culmination of an activity

or event associated with the row. Likewise, in (12-c), the aspectual verb *started* does not express the initiation of an event related to the sentential complement, 'the morning,' but rather is understood as situating it's subject, 'a thunderstorm,' at the beginning of the dimension (perhaps a temporal one in this case) along which 'the morning' is understand. Thus, while it is clear that the complement coercion constructions considered above exhibit the availability (and arguably the necessity) of an eventive interpretation, it is not clear how the diagnostic of an entity-NP in combination with a coercion verb yielding an eventive interpretation captures a semantically homogeneous class of predicates, given that said predicates do not strictly select for events. Such observations have motivated the development of an alternative view of complement coercion, as well as the lexical semantics of the relevant verbs. This approach, known as the Structured Individuals Hypothesis, is reviewed below.

3.1.4 The Structured Individuals Hypothesis

Based on the weaknesses facing type-shifting accounts of complement coercion, Piñango and Deo (2012, 2016) and Lai et al. (2014, 2016) argue for a unified analysis for aspectual verbs, which distinguishes them from both the psychological verbs, as well as the "other" identified coercion verbs—in effect proposing a redefinition of the set of "coercion" verbs such that only aspectual verbs are included.

Recent proposals label the approach the 'Structured Individuals Hypothesis' (SIH) on account of the fact that aspectual predicates are analyzed as selecting not for eventive complements, but rather, for 'structured individuals' or incremental theme arguments—i.e., entities which can be conceptualized as structures composed of parts ordered along some salient axis or dimension (of which events are a type) (Lai et al. 2016). The hypothesis suggests that the lexical entry for each aspectual verb encodes a set of functions for mapping complement denotations to specific dimensions (e.g., $f$space, $f$time, $f$info), and that all sentences involving aspectual predicates are semantically ambiguous regarding the dimension along which the complement is to be interpreted.

On this account, the type of reading assigned to an expression containing an aspectual predicate depends on two factors: whether the subject is animate or not, and the choice of dimension along which incremental theme argument is to be interpreted (Lai et al. 2016:4).

If the subject of an aspectual verb is inanimate, for example, the analysis predicts that their composition will give rise to a constitutive reading. If the subject is animate, on the other hand, a constitutive reading may still be available; however, in this case (and only in this case), the hypothesis predicts an additional, "agentive" reading, understood along an eventive dimension, to be available.

Thus this approach establishes the existence of a superset relation between constitutive and agentive readings of aspectual verbs, such that agentive readings are predicted to be available only in the event of an animate subject; however, constitutive readings are predicted to be available regardless of the subject's animacy (Lai et al. 2016:5).

Reconsidering the examples in (12) in light of this analysis seems to add credence to the hypothesis: '*the Appalachian Trail*,' for instance, in (12-a) denotes a structured individual (namely, a path), which can be measured along a spatial dimension, and of which '*begin*' picks out the initial subpart. Similarly, '*the morning*' in (12-c) denotes an incremental theme understood along a temporal dimension. In the case of complement coercion constructions like '*The woman began the book*,' which has an animate subject, an agentive reading is available, in which the incremental theme object '*the book*' is interpreted along an eventive dimension. However, the prediction that the choice of subject (animate vs. inanimate) and choice of dimension will alone determine whether an agentive reading is available is not borne out in all cases, as illustrated by the sentence in example (13), which has an agentive reading (understood along an eventive dimension) despite lacking an animate subject. The authors do not note this exception.

(13) The printer started my paper. (Lai et al. 2016:5)

Moreover, if only aspectual verbs participate in complement coercion, there is no obvious explanation for the availability of an eventive interpretation in sentences where, for example, a psychological verb takes an entity-denoting noun as its internal argument and nevertheless yields an eventive interpretation, as with the sentence '*Alice enjoyed her morning coffee*.' Thus, while the structured individual hypothesis has clear advantages, it is not obvious that this account is superior to a type-shifting approach in its ability to account for the facts.

While both the SIH and type-shifting proposals characterize complement coercion sen-

tences as being computationally more complex than non-coercive sentences, the SIH predicts the complexity to be present only in the case of aspectual verbs, regardless of whether they engender the "constitutive reading," and attribute the complexity to the process of disambiguating the dimension along which the complement is to be understood. The type-shifting accounts, on the other hand, attribute the complexity to the detection of a type-mismatch and subsequent insertion/activation of a type-shifting, or coercion, operator, and predict its presence in coercive environments involving all of the verbs identified in §3—that is, the aspectual, psychological, and "other" verbs.

In order to determine which (if either) of these predictions is borne out, let's now turn our attention to the empirical evidence put forth by psycholinguistic investigations into the processing of complement coercion sentences.

3.2 Experimental literature

Several studies have found evidence suggesting that coercive sentences are harder to process[13] than non-coercive ones, in otherwise neutral contexts (Frisson & McElree 2008; McElree et al. 2001; Pickering et al. 2005; Traxler et al. 2002b). Among the first to experimentally investigate the processing correlates of complement coercion were McElree, Traxler, Pickering, Seely, and Jackendoff (2001), who tested 33 native English speakers using a self-paced reading paradigm, comparing word-by-word reading times across the three types of sentences presented in (14).

(14) a. The author was starting the book in his house on the island. (coercion)
b. The author was writing the book in his house on the island. (preferred)
c. The author was reading the book in his house on the island. (non-preferred)

The authors hypothesized that if selectional mismatches between a verb and its complement trigger semantic type-shifting or enrichment operations, then sentences with mismatching elements should engender longer reading times than sentences whose arguments straightforwardly satisfy the selectional requirements of the verb (McElree et al. 2001:B21). The three conditions exemplified in (14) were chosen with the idea in mind

[13]The studies reviewed in this section operationalize processing difficulty as reliable differences in reading times, where longer reading times are thought to reflect greater difficulty in computing the meaning of a given expression (Lowder & Gordon 2016:923).

that (14-b) & (14-c), where the verb/complement pairs straightforwardly compose, would serve as controls, but chose preferred (14-b) and non-preferred (14-c) versions of the controls in order to rule out the possibility of prototype effects influencing their results. They reasoned that comprehenders may process prototypical or familiar verb/complement pairs more readily than less prototypical pairs, but predicted that such an effect would be smaller than if the verb/complement pair required a type-shifting operation to enable composition. 'Preferred' and 'non-preferred' sentences were derived using a cloze test, in which over two hundred participants provided fill-in-the-blank responses to sentences like '*The author was starting* _____ *the book*' where the most common responses were used for the preferred condition, and the least common (though still plausible) responses were used for the non-preferred condition (McElree et al. 2001:B20).

At the verb region, no significant differences in reading times emerged across the three conditions; however, at the complement NP (*the book*) and NP+1 (*in*) regions, reading times were significantly longer in the coercion condition. While reading times were slower in the non-preferred condition than in the preferred condition at the complement NP, there were no differences in reading times between the two control sentences beyond this region, suggesting that the relative slow-down in the non-preferred condition was due to the non-prototypical complement. The fact that the slow-down in reading times persisted into the NP+1 region in the coercion condition was taken as evidence that interpreting coercive sentences is computationally more costly than interpreting non-coercive ones due to the need for a type-shifting repair mechanism during the process of composition (McElree et al. 2001:B22).

Traxler, Pickering, and McElree (2002) followed up on this study with three experiments using both self-paced reading and eye-tracking methodologies. Experiment 1 served as a manipulation check, replicating the study done by McElree et al. (2001), using eye-tracking rather than self-paced reading. Again it was found that sentences in the coercion condition incurred longer reading times at the complement NP and NP+1 regions than either control (Traxler et al. 2002b:535). Still, given the possibility that reading times were longer in the coerced environment simply because readers have more difficulty in general with assigning eventive interpretations, or alternatively, simply because verbs like *begin* and *start* are semantically less specific than verbs like *read*, thus requiring more interpre-

tive processing, the authors designed an additional experiment to test these hypotheses. Experiment 2 investigated these possibilities by comparing reading measures at the verb, complement NP, and NP+1 regions for sentences across the four conditions illustrated in (15).

(15) a. The boy started the fight after school today. (event + event)
b. The boy saw the fight after school today. (neutral + event)
c. The boy started the puzzle after school today. (event + entity)
d. The boy saw the puzzle after school today. (neutral + entity)

(Traxler et al. 2002b:537)

If eventive-NPs were simply harder to process than non-eventive NPs, sentences such as (15-a)—(15-b) were expected to be more difficult (i.e., read more slowly) than (15-c)—(15-d). If, on the other hand, the verbs used in the previous coercion studies were simply harder to process due to semantic properties, a main effect of verb type was expected to emerge such that (15-a) & (15-c) were more difficult. Instead, what the authors found was an interaction between verb-type and NP-type, such that reading times were longer for sentences with event-selecting (or coercion) verbs and entity-denoting NPs (15-c) at the NP and NP+1 regions, again suggesting that readers experience processing difficulty only when the default interpretation of an NP is incompatible with the that of the selecting verb (Traxler et al. 2002b:540). Experiment 3 replicated experiment 2 using self-paced reading, and found results consistent with both experiments 1 and 2. The authors conclude that these results "provide further evidence that self-paced reading and eye-movement monitoring can lead to similar results for semantic processing" (Traxler et al. 2002b:542).

Pickering, McElree, and Traxler (2005) also adopt an eye-tracking procedure, this time testing the addition of a full-VP preferred condition,[14] as shown in (16-d).

(16) a. The carpenter began the table during the morning break. (coerced)
b. The carpenter built the table during the morning break. (preferred)
c. The carpenter sanded the table during the morning break. (non-preferred)

[14]Where preferred and non-preferred readings were again established using a cloze probability survey (Pickering et al. 2005).

d. The carpenter began building the table during the morning break. (full-VP preferred)

Again, significantly longer reading times were found at the complement NP and NP+1 regions only in the coerced condition, indicating that the processing cost emerged from mismatching type specifications between the verb and NP complement, since the same coercion verbs did not yield a processing cost when combined with a verbal complement (i.e., the full-VP preferred condition) (Pickering et al. 2005).

Still, the possibility remained that the processing cost previously associated with complement coercion sentences could be due to the need for selecting a single interpretation out of several competing interpretations (i.e., ambiguity resolution). To investigate this possibility, Frisson and McElree (2008) tested 40 native English speakers, again using an eye-tracking methodology, on sentences with weakly and strongly constrained interpretations (Frisson & McElree 2008). Examples of their stimuli are presented in (17).

(17) a. The teenager began the novel as soon as he got to his room upstairs. (strongly preferred, coerced)

b. The teenager read the novel as soon as he got to his room upstairs. (strongly preferred, control)

c. The waitress started the coffee as soon as she returned to the counter. (weakly preferred, coerced)

d. The waitress served the coffee as soon as she returned to the counter. (weakly preferred, control)

The authors reasoned that if the observed processing cost is in fact due to inherent ambiguity in these sentences, then the magnitude of the processing cost should be greater in sentences such as (17-c), which have several likely interpretations, than in sentences such as (17-a), which have a single prominent interpretation.[15] The authors found that,

[15]The strongly vs. weakly preferred interpretations were again determined using a cloze probability test similar to that used in McElree et al. 2001; for the strongly preferred coercion condition, the dominant interpretation was used an average of 90.4% of the time, where the ratio of most-frequent to second-most-frequent response was 14:1, suggesting a single, strongly-preferred interpretation. For the weakly-preferred condition, this ratio was 2:1, with the most frequent response being provided an average of 45.4% of the time (Frisson & McElree 2008:5).

contra the ambiguity resolution hypothesis, the magnitude of the coercion effect did not differ depending on how strongly or weakly constrained the possible interpretations for a coercive sentence were. These findings have been taken to suggest that it is the process of constructing an eventive interpretation, and not the disambiguation of possible interpretations, which causes the observed processing cost (Frisson & McElree 2008:7).

Similar findings have been demonstrated using other time-sensitive measures such as ERP (Baggio et al. 2010; Kuperberg et al. 2010). While the details of these studies are not particularly germane to the present discussion (and are thus not reviewed in detail), it is worth noting that in these studies, the NP complements in coercion sentences evoked a significantly larger N400 amplitudes than NP complements in the control conditions (Baggio et al. 2010) and similar N400 amplitudes to that of NPs in highly-implausible sentences with animacy violations (Kuperberg et al. 2010). While N400 measures have been linked to both semantic integration as well as to lexical access (Kutas & Federmeier 2000; Lau et al. 2008), they have also been linked to a word's surprisal factor, or expectancy within a given context, such that the less expected a word is in some context, the larger the N400 amplitude (Kutas & Hillyard 1984). In the complement coercion cases, the authors of these studies have attributed the N400 effects to the detection of a mismatch in types between the semantic properties of the complement NP and selectional restrictions of the verb (Kuperberg et al. 2010).

Based on the empirical evidence covered thus far, the type-shifting approach to complement coercion appears to be most promising. Not only is there empirical evidence consistent with the type-shifting hypothesis—that is, the fact that coercion effects emerge at just the point in processing when the supposed type conflict is thought to be encountered—but also, evidence put forth by Frisson and McElree (2008) from an experiment designed to directly test whether the observed coercion costs could be attributed to ambiguity resolution indicates that ambiguity cannot be the culprit (Frisson & McElree 2008). Of course it is possible that these findings only pertain to lexical ambiguity, while the difficulty observed in complement coercion sentences is actually the result of a dimensional ambiguity as suggested by the SIH. If so, the fact that processing difficulty is observed at the point of encountering the critical NP and slightly after could just as reasonably be explained as the process of selecting the correct dimension along which to interpret the verb's internal

argument.

Still, evidence put forth by Traxler et al. (2002) also seems to favor a type-shifting account over the SIH. The fact that no coercion cost was observed in sentences involving coercion verbs with eventive NP complements goes against predictions of the SIH, which expects a processing cost to emerge any time an aspectual verb is encountered, since (by hypothesis) there will always be ambiguity regarding which dimensional function to activate when composition with aspectual verbs occurs. Nevertheless, recent evidence suggests that there may still be hope for the SIH.

While all of the studies discussed so far have treated the so-called "coercion verbs" as a homogeneous set, Katsika et al. (2012) argue that these studies suffer from a serious confound arising from apparently unacknowledged "lexico-semantic differences" between two classes of verbs used in their stimuli: aspectual and psychological verbs (Katsika et al. 2012:60). The authors present evidence from an eye-tracking study contrasting sentences with aspectual, psychological, and control verbs (shown in (18)), which indicates that the psychological verbs used in previous complement coercion studies behave as controls, while only the aspectual verbs display the expected coercion cost.

(18) a. Alexandra was completing a sci-fi book when the secretary announced the meeting. (aspectual)
b. Alexandra was enjoying a sci-fi book when the secretary announced the meeting. (psychological)
c. Alexandra was shelving a sci-fi book when the secretary announced the meeting. (control)

The authors note that while an eventive interpretation does seem to arise with all the verbs used in the previous studies, "in the absence of more robust syntactic or semantic shared properties, the hypothesis that eventive inferences must be attributed to the same mechanism of building meaning (coercion + type shifting) is too strong" (Katsika et al. 2012:61). Instead, they argue that only aspectual verbs in these constructions involve type-shifting, while the psychological verbs simply involve pragmatic inferencing—the effects of which are predicted to emerge later than the effects of type-shifting since, on their assumption, pragmatic inferencing takes effect at a later stage of processing (Katsika

et al. 2012:58).

Lai et al. (2014) present similar findings from a self-paced reading study designed instead to test the viability of the dimensional ambiguity hypothesis. In their study, participants were presented with sentences from three conditions (aspectual verbs, psychological verbs, and control verbs) as exemplified in (19).

(19) [Lady Gaga]$_1$ [started$_{(AspectualV)}$ / preferred$_{(EnjoyingV)}$ /loved$_{(LovingV)}$]$_2$ [this CD]$_3$ [of]$_4$ [American]$_5$ [pop hits.]$_6$

(Lai et al. 2014:4)

They hypothesized that only sentences in the aspectual verb condition would engender a processing cost, while sentences in the *enjoy*-type psychological verb condition and *love*-type psychological verb condition (which served as their control condition) would not, since according to the SIH, only aspectual verbs involve necessary ambiguity resolution (Lai et al. 2014:4). Their findings replicated those of Katsika et al. (2012) in showing evidence of a processing cost at the NP+1 and NP+2 regions (their regions 4 and 5 as reflected in (19)) only in the aspectual verb condition. Again, results from the *enjoy*-type verb condition did not differ from the control condition on any of the relevant measures.

However, while this evidence is compelling, it may not be as conclusive as it appears. In Katsika et al. (2012), for example, many of the verbs used in the control condition were very low-frequency (e.g., *unearth, peruse, subscribe to, conduct, submit, shelve*) compared with the verbs in the test conditions, which could have had an influence on the speed with which these sentences were processed by participants. Moreover, at their critical region (which included both the verb and complement), one reading measure revealed a significant effect in only the aspectual verb condition, while a different measure for the same region revealed a significant effect in only the control condition. Similarly, in their continuation region (comparable to the NP+1 regions of the other studies), one reading measure revealed a main effect of verb in the aspectual condition, while another measure indicated that aspectual verbs were significantly different from the controls, while the psychological verbs did not statistically differ from either the aspectual verb or control conditions (Katsika et al. 2012:66).

Similarly, in Lai et al. (2014), while the aim was again to test differences in the pro-

cessing profiles of verbs from different semantic classes, the verbs comprising their control condition, like those in their *enjoy*-typeV test condition, were from the semantic class of subject-experiencer psychological verbs (Landau 2009:6). This confounds their results since the *love*-type verbs cannot serve as a true control for testing differences between semantic classes of verbs if they are from the same semantic class as the test groups. Moreover, in their example stimuli presented in (19), the aspectual verb permits both a coerced reading with an eventive interpretation, as well as a constitutive reading with a metonymic subject[16] (that is, the sentence could be taken to express that the first song on the CD in question happened to be a Lady Gaga song), thus, if (19) is representative of their stimuli on the whole in this regard, the differences in reading measures observed in this study could be confounded by ambiguity between an eventive and constitutive reading of the aspectual verbs. Thus, while the evidence presented in these two studies seems to suggest that the psychological verbs previously used in investigations of complement coercion do not actually incur a processing cost, the book has not been closed on the matter.

In recent investigations concerning the interaction of semantic and syntactic complexity, Lowder and Gordon (2015, 2016) present evidence that the coercion cost associated with processing complement coercion sentences is significantly reduced when the critical constituents—the entity-NP and event-selecting verb—are separated by a clause boundary. Lowder and Gordon (2015), for example, conducted two eye-tracking studies where they tested whether putting the coercing verb and entity-NP complement in different clauses of the same sentence would have an effect of the magnitude of the coercion cost. In Experiment 1, they presented speakers with coercive and non-coercive sentences in the passive form, with and without relative clauses, as shown in (20).

(20) a. [The memo was begun by the secretary this morning…] (Simple, Coercion)

b. [The memo [that was begun/written by the secretary this morning…]] (RC, Coercion)

c. [The memo was written by the secretary this morning…]] (Simple Control)

[16]Unlike in the cases of Lai et al. (2014) and Katsika et al. (2012), the stimuli used in previous studies on complement coercion have consistently been published in their entirety, and do not suffer from this potential point of ambiguity; sentences used in coercion conditions have consistently permitted only a coerced interpretation.

d. [The memo [that was written by the secretary this morning. . .]] (RC, Control)

In Experiment 2, they replicated the design of Experiment 1, only this time using clefts and pseudoclefts, as shown in (21).

(21) a. [It was the secretary that began/wrote the memo. . .] (Cleft, Coercive)
b. [It was the secretary that began/wrote the memo. . .] (Cleft, Control)
c. [What the secretary began/wrote [was the memo. . .]] (Pseudocleft, Coercive)
d. [What the secretary began/wrote [was the memo. . .]] (Pseudocleft, Control)

By introducing the relative clause and pseudocleft constructions, the authors were able to create a clause boundary between the coercing verb (*begin*) and it's entity complement (*the memo*), as indicated by the brackets in (20) and (21). In both experiments, they found that the magnitude of the coercion cost was significantly reduced when the critical constituents were separated by a clause boundary (Lowder & Gordon 2015). In the simple sentences and cleft sentences, there was a significant slow-down in reading measures at the critical NP and NP+1 regions as compared to controls, reflecting the previous findings on complement coercion. However, this effect was mitigated by the introduction of a clause boundary, such that in the pseudocleft and relative clause conditions, no statistically significant effects emerged at any of the relevant regions; coercive sentences where the critical constituents appeared in separate clauses looked statistically identical to control sentences without coercing elements.

In addition to providing contexts for the introduction of a clause boundary, the use of passive and cleft constructions in these experiments allowed the researchers to investigate whether the mitigating effect of the clause boundary would appear regardless of the degree of focus placed on the critical NP. That is, in the pseudocleft environment, the NP is in a focalized position, while in the passive RC condition, it is in a subordinate clause, considered a deemphasized position (Baker & Wagner 1987). The fact that the mitigating effect emerged regardless of the structural importance of the complement NP is taken by the authors as a strong indication of how structure can importantly influence the relationship between elements in a sentences (Lowder & Gordon 2015:534).

In 2016, Lowder and Gordon again investigated this mitigating effect of sentence structure on complement coercion using eye-tracking methodology. In Experiment 1, the au-

thors investigated whether simply embedding the coercive elements together within a relative clause was sufficient for reducing the processing cost associated with complement coercion (Lowder & Gordon 2016). The reasoning behind this design was motivated by evidence put forth by Baker and Wagner (1987), who found that participants were poorer at detecting false or contradictory information when it was contained within a subordinate clause than when it was presented in the main clause, suggesting that information contained in structurally subordinate positions may simply be processed at a shallower level than information contained in the main clause. Thus, it could be the case that the mitigating effect observed in Lowder and Gordon (2015) was simply due to logical subordination of information, rather than structural deemphasis of the *relationship* between the relevant constituents. To test this possibility, the authors compared reading times for coercive and non-coercive subject relative clause (SRC) constructions, which place both the critical verb and NP complement together within the embedded clause (again, thought to be a structurally defocalized position (Baker & Wagner 1987)), and simple sentences, which present the critical constituents together in the main clause. An example of their stimuli is shown in (22).

(22) a. [The secretary began the memo about the new office policy…] (Simple, Coercion)

b. [The secretary wrote the memo about the new office policy…] (Simple, Control)

c. [The secretary [that began the memo about the new office policy…]] (SRC, Coercion)

d. [The secretary [that wrote the memo about the new office policy…]] (SRC, Control)

While there was a significant effect of coercion such that the coercion conditions elicited longer reading measures at the NP and NP+1 regions than the controls, no significant differences in the magnitude of the coercion effect were observed across the two clause types, suggesting that structural deemphasis of the constituents via clausal subordination in the SRCs did not cause the relationship between them to be processed at a more shallow level (Lowder & Gordon 2016:925).

This study was followed up by Experiment 2 where the authors again tested the hypothesis that separating the critical constituents with a clause boundary would mitigate the effects of complement coercion. In this experiment, they used the same SRCs from experiment 1, but instead of contrasting these with simple sentences, they used object-relative clause (ORC) constructions, which place the complement in the main clause and the coercing verb in the embedded clause, as shown in (23).

(23) a. [The memo [that the secretary began] announced that…]] (ORC, Coercion)
b. [The memo [that the secretary wrote] announced that…]] (ORC, Control)
c. [The secretary [that began the memo about the new office policy…]] (SRC, Coercion)
d. [The secretary [that wrote the memo about the new office policy…]] (SRC, Control)

SRCs and ORCs provide a particularly interesting testing ground for this hypothesis since it is well established in the literature that ORCs are more difficult to process (i.e. engender longer reading times) than their SRC counterparts (Gordon et al. 2001; Staub 2010; Traxler et al. 2002a). However, contra the standard ORC-SRC asymmetry, the authors found no significant differences between SRCs and ORCs in the coercion condition across any reading measures (Lowder & Gordon 2016:932). This was not the case for their control condition, which exhibited the standard asymmetry, with ORCs being significantly more difficult than SRCs. Based on these findings, the authors speculated that the structural separation of the coercive elements in the ORCs mitigated the coercion effect; however, since there was no structural separation between coercive elements in the SRC environment, the coercion effect fully emerged, making them just as difficult to process as the ORCs (Lowder & Gordon 2016:934).

The stimuli used by Lowder and Gordon was adapted from earlier studies on complement coercion discussed above, and though they acknowledge the findings of Katsika et al. (2012), their stimuli nevertheless treat the aspectual and psychological verbs identified in the literature on complement coercion and used in previous experiments as a homogeneous set. As the authors themselves note, "it is unclear whether and to what extent the modulating effects of sentence structure observed in [(Lowder & Gordon 2016)] and in

[(Lowder & Gordon 2015)] depend on verb subclass difference; this remains an important area for future research" (Lowder & Gordon 2016:931).

Indeed, given that coercion effects were observed even when the psychological verbs in question made up a significant proportion of experimental stimuli (even constituting the majority of experimental stimuli in some cases, e.g., Frisson and McElree, 2008), further research is necessary before it can be determined whether both psychological and aspectual verbs in complement coercion contexts engender a processing cost, and whether the modulating effects of sentence structure are in fact due to semantic features associated with only a subset of the coercion verbs. In the next section, I will describe the details of an experiment designed to test this possibility.

CHAPTER 4

THE EXPERIMENT

Following the design of Lowder and Gordon (2016), the present study aims to fill this gap in our understanding of complement coercion phenomena by investigating whether both classes of coercion verbs (aspectual and psychological) discussed in the literature, and used in previous studies, display similar modulating effects in ORCs as compared to SRCs. While replicating the design of earlier studies which utilize simple-sentence constructions may speak to potential differences between the verb classes with respect to complement coercion, the use of more complex sentence structures, such as ORCs and SRCs, additionally allows for the investigation of whether their semantic differences are relevant for the modulation of coercion effects in different sentential contexts, which could potentially tell us even more about how the relationship between coercive constituents is computed.

4.1 Method

To investigate the potential differences between the two classes of verbs with respect to both the presence and mitigation of a coercion effect, I adopt a self-paced reading, moving-window paradigm, implemented on a PC using Linger software (a psycholinguistic experimentation framework written by Doug Rohde of Tedlab, 2001) and equipped with a mechanical gaming keyboard with a sampling rate of 1000hz.

4.1.1 Hypotheses

Following McElree et al. (2001), Traxler et al. (2002; 2005), who have observed reliable effects at the complement NP and NP+1 regions, the primary regions of interest for the present study are: the initial coercion cue (the complement NP in SRCs and the embedded verb in ORCs) and the matrix verb (i.e., the NP+1 region). If the psychological verbs used in previous coercion studies indeed behave like controls, as predicted by Katsika

et al. (2012) and Lai et al. (2014), we should expect an interaction between verb-type and structure-type such that ORCs are harder to process at the relevant regions than SRCs only in the psychological-verb condition (thus reflecting the standard ORC/SRC asymmetry), while in the aspectual-verb condition, ORCs and SRCs should not differ in reading times for the relevant regions (consistent with the findings of Lowder and Gordon, 2016).

Alternatively, if the psychological verbs used in previous coercion studies behave as the other coercion verbs, no significant differences are expected to emerge at either of the regions of interest across the two experimental conditions; and importantly, for both aspectual and psychological verb conditions, reading times for SRCs should be identical to that of ORCs, contra the standard ORC-SRC asymmetry.

4.1.2 Participants

Forty native English speaking speakers, recruited from the University of Utah undergraduate research pool, participated in this study in exchange for course credit.

4.1.3 Stimuli

Experimental items consisted of 18 experimental quartets following the example presented in (1) where the complement NP was positioned as the subject of the main clause and extracted object of the RC containing the coercing verb in ORCs ((1-a) and (1-c)), or where both the NP complement and coercing verb were positioned together within the embedded clause of the SRCs ((1-b) and (1-d)) (see Appendix for the full list of experimental items).

(1) a. The memo that the secretary began announced that there would be pay raises for all the employees. (Aspectual-ORC)

b. The secretary that began the memo announced that there would be pay raises for all the employees. (Aspectual-SRC)

c. The textbook that the student endured provided valuable insight into fixing the computer problems. (Psychological-ORC)

d. The student that endured the textbook provided valuable insight into fixing the computer problems. (Psychological-SRC)

Because the experimental stimuli used in Lowder and Gordon (2016) did not contain an

equal number of instances for each of the verb classes of interest, stimuli from Frisson and McElree (2008) and Traxler and Pickering et al. (2002) were also included. In these cases, the sentences were adapted to fit the SRC structures by inserting the complementizer '*that*' after the subject NP. Sentences for the ORC condition were then generated by positioning the target NP of the SRC as the sentence subject and embedding the agent inside the RC along with the verb. The remainder of the sentences were re-written to include a matrix verb and post-verb material that could be attributed to the head NP of either the SRC or the ORC constructions.

Test items were divided across two lists so that each participant saw one ORC and one SRC from each experimental quartet without repetition of the verb (e.g., (1-a) and (1-d), or (1-b) and (1-c)) and so that there was an equal number of sentences from each condition across the two lists. Each list was also presented in its reverse order, and the resulting four lists were randomly assigned to participants, with 10 participants completing each list; thus obtaining 36 data points per subject. The experimental stimuli were combined with 90 filler sentences of various types yielding a total of 126 sentences, and item presentation followed a random order, with test items being separated by at least one filler sentence.

4.1.3.1 Stimuli norming

4.1.3.1.1 Word-length. To ensure that any differences observed between the two verb groups were not due to differences in the lengths of the words at the critical regions, stimuli were balanced for word length. One-way between-subject ANOVAs with verb-type as the independent variable (two levels: Aspectual and Psychological) and character-count (for the embedded verbs, matrix verbs, and complement NPs) as the dependent measure were conducted. Character-counts for the aspectual-verbs condition in the embedded verbs (M=7.89, SD=.212); matrix verbs (M=6.78, SD=1.987); and target NPs (M=6.11, SD=2.111) did not differ from those in the psychological-verbs condition in the embedded verbs (M=7.67, SD=.343), $F(1,34)=.304$, $p=.585$; matrix verbs (M=7.33, SD=1.940), $F(1,34)=.720$, $p=.402$; or target NPs (M=6.17, SD=1.689), $F(1,34)=.008$, $p=.931$.

4.1.3.1.2 Plausibility. To ensure that any differences observed between the two verb types are not due to differences in the plausibility of the sentences, stimuli were normed for plausibility using an on-line survey hosted through Qualtrics (Snow & Mann 2013).

The 72 experimental sentences were divided across two lists, and combined with 40 filler sentences following the plausibility procedure used in Frisson and McElree (2008). Filler items included many implausible sentences to encourage participants to take advantage of the full range of the rating scale. Participants were instructed to read each sentence at a comfortable pace and to indicate how plausible each sentence was on a scale of 1 (totally implausible/makes no sense) to 7 (perfectly plausible/makes total sense). The two lists were presented in random order and complete by 36 and 49 participants, respectively. The data were submitted to a one-way within-subjects ANOVA with verb-type as the independent variable (two levels: Aspectual-verbs and Psychological-verbs) and plausibility ratings as the dependent measure. Plausibility ratings for the Aspectual verb condition (M=5.69, SD=.906) did not differ from that of the psychological verb condition (M=5.58, SD=.932), F(1,84)=2.781, p=.099.

4.1.3.1.3 Frequency. The verbs used in the present study were also compared for frequency using the SUBTLEX-US corpus, a web-based corpus containing over 51 million words sampled from American English subtitles (Brysbaert & New 2009). Log frequencies for the Aspectual verbs (M=3.646, SD=.353) were compared to that of the Psychological verbs (M=2.915, SD=.514) using a one-way between-subjects ANOVA with verb-type as the independent variable (two levels: Aspectual and Psychological) and log frequency as the dependent measure.[1] Results indicate that verbs in the Aspectual-verbs condition were significantly more frequent than verbs in the Psychological-verbs condition F(1,8)=6.870, p=.031. While this difference could have an influence on reading times, the prediction would be that the higher frequency of Aspectual verbs could lead to faster reading times at the verb region in the Aspectual-verbs condition relative to the Psychological-verbs condition, thus any differences observed between the two verb classes of verbs that are compatible with the hypothesis that psychological verbs behave as controls would be strengthened by this fact. The flip side of this, of course, is that the differences in frequency between the verb classes could constitute a limitation for interpreting results that suggest no difference between the them. In such a case, it is possible that any observed

[1]Log frequencies, rather than raw frequencies (Aspectual verbs: M=6430.8, SD=6179.48; Psychological verbs: M=1088.4,SD=986.06), on the basis of non-linear transformations being recommended to satisfy assumptions of normality; i.e., to prevent extreme outliers in the data from obscuring trends characteristic of the data-set on the whole (Lo & Andrews 2015).

slow-down in reading times for the Psychological-verbs condition could be attributable to their relatively low frequencies; however, in such a case, effects are not expected to persist beyond the point at which the relevant verb is encountered (McElree et al. 2001).

4.1.4 Procedure

After providing consent, participants were seated in front of a computer monitor in a quiet room and instructed to read at a normal, comfortable pace that would enable them to answer comprehension questions. Sentences were presented with a self-paced moving window procedure using a PC with a mechanical gaming keyboard with a sampling rate of 1000hz and Linger experimental software (Rohde 2005). Each trial began with a fixation cross presented in the center of the screen. With the first press of the space-bar, a sentence, masked by dashes replacing the letters in each word, appeared. The next press of the space-bar revealed the first word in the sentence, and with each subsequent press of the space-bar, the next word was revealed while the previous word was re-masked. After the final word in the sentence was revealed, the next space-bar press revealed a true-false comprehension question which did not probe readers' interpretations of the coerced expressions (Lowder & Gordon 2016). Participants responded to the comprehension questions by pressing either 'F' for 'YES' or 'J' for 'NO,' and feedback was provided only for wrong answer responses in order to encourage participants to pay attention.

The computer recorded the time intervals from the point at which a first word was displayed until the subsequent press of the space bar. Each participant began the task with a 4-filler sentence warm-up block before moving on to the remaining 122 sentences.

4.2 Results

Reading times longer than 2000ms[2] (0.25% of the data) were excluded from the analysis. All participants included in the analysis scored at least 90% correct on comprehension questions. This criterion excluded data from one participant (2% of the data) who received only 80% accuracy on comprehension questions. Mean self-paced reading times are presented by region and condition in Table 4.1. On the basis of previous findings (Lowder & Gordon 2016; McElree et al. 2001; Traxler et al. 2002b), data analysis focused on two critical

[2]Following Traxler et al. (2002) who also use self-paced reading methodology (Traxler et al. 2002b:541).

Table 4.1. Mean reading times

Asp-SRC	*The secretary that began the memo announced that...*
Asp-ORC	*The memo that the secretary began announced that...*
Psych-SRC	*The student that endured the textbook provided valuable...*
Psych-ORC	*The textbook that the student endured provided valuable...*

Measure (in milliseconds)	*Target NP (e.g., memo)*	*Embedded Verb (e.g., began vs. enjoyed)*	*Initial Coercion Cue (e.g., memo vs. began)*	*Matrix Verb (e.g., announced)*	*+ 1 (e.g., that)*
Asp-SRC	-	414.48	419.56	459.74	429.76
Asp-ORC	426.64	-	422.46	471.10	447.71
Psych-SRC	-	418.83	422.65	466.70	439.70
Psych-ORC	403.15	-	455.24	492.20	442.90

Notes: NP = noun phrase, SRC = subject relative clause, ORC = object relative clause. The initial coercion cue described in the text corresponds to the target NP in SRCs, and the embedded verb in ORCs.

regions: the initial coercion cue (the embedded verb in ORCs vs. the complement NP in SRCs) and the matrix verb.

4.2.1 Comprehension-question accuracy

Mean comprehension question accuracy for each of the four experimental conditions is as follows: Aspectual-ORC (96%), Aspectual-SRC (96%), Psychological-ORC (97%), and Psychological-SRC (98%). There were no significant differences between the conditions.

4.2.2 Initial coercion cue

Reading time data from the initial coercion cue region were submitted to a two-way repeated measures ANOVA with verb-type (two levels: Aspectual and Psychological) and structure-type (two levels: SRC and ORC) as the independent variables, and reading times at the initial coercion cue region as the dependent measure. Reading times for Aspectual verbs in the SRC condition (M=419.56, SD=185.56) and in the ORC condition (M=422.46, SD=162.91) did not differ from that of Psychological verbs in the SRC condition (M=422.65, SD=157.46) or in the ORC condition (M=455.24, SD=200.12). There was no main effect of verb, $F(1,39)=2.65$, $p=.111$; no main effect of structure type, $F(1,39)=2.270$, $p=.140$; and no significant interaction, $F(1,39)=1.689$, $p=.201$. This is illustrated in the graph in Figure 4.1.

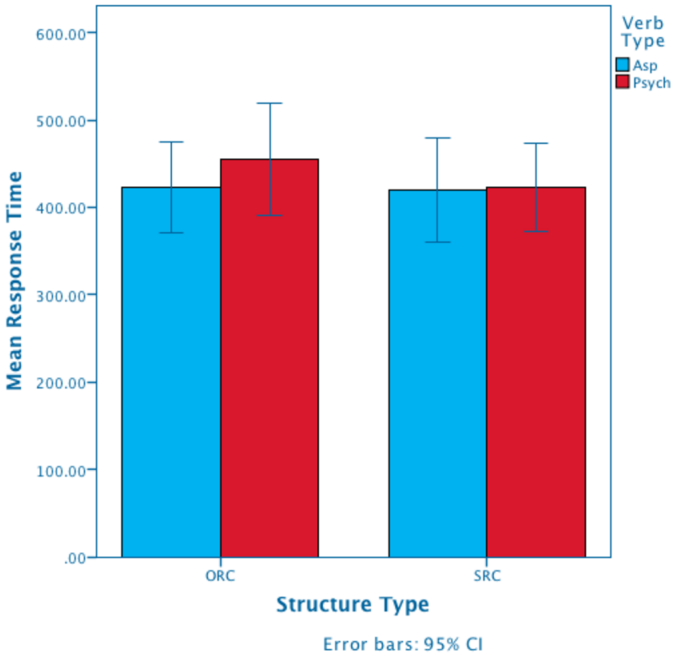


Figure 4.1. Mean reading times (in milliseconds) for the initial coercion cue region

4.2.3 Matrix verb

Reading time data from the matrix verb region were submitted to a two-way repeated measures ANOVA with verb-type (two levels: Aspectual and Psychological) and structure-type (two levels: SRC and ORC) as the independent variables, and reading times at the matrix verb region as the dependent measure. Reading times for Aspectual verbs in the SRC condition (M=459.74, SD=194.59) and in the ORC condition (M=471.09, SD=211.15) did not differ from that of Psychological verbs in the SRC condition (M=466.70, SD=191.71) or in the ORC condition (M=492.18, SD=172.94). There was no main effect of verb, $F(1,39)=1.397$, $p=.244$; no main effect of structure type, $F(1,39)=1.555$, $p=.220$; and no significant interaction, $F(1,39)=.269$, $p=.607$. This is illustrated in the graph in Figure 4.2.

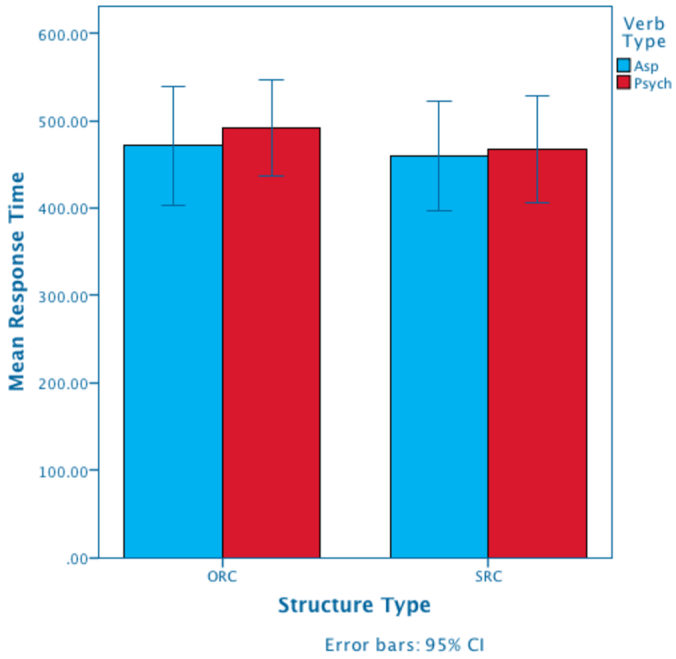


Figure 4.2. Mean reading times (in milliseconds) for matrix verb region

Given that no effects emerged at the critical regions, data from the Matrix Verb + 1 region, the Embedded Verb, and the Target NP (as shown in Table 4.1), as well as the Matrix Verb + 2 region, were also analyzed using two-way repeated measures ANOVAs with verb-type (two levels: Aspectual and Psychological) and structure-type (two levels: SRC and ORC) as the independent variables, and reading times at the relevant region as the dependent measure.

4.2.4 Carry-Over Region

To examine potential differences in carry-over effects from previous regions, reading time measures from the Matrix Verb + 1 and Matrix Verb + 2 regions were also analyzed. Results from the Matrix Verb + 1 region revealed no ME of verb ($F(1,39)=.210$, $p=.649$), no ME of structure-type ($F(1,39)=.957$, $p=.334$), and no significant interaction ($F(1,39)=.948$, $p=.336$) between conditions for the Aspectual-SRC ($M=429.13$, $SD=126.91$), Aspectual-ORC ($M=447.14$, $SD=115.40$), Psychological-SRC ($M=441.96$, $SD= 130.24$), and Psychological-ORC ($M=443.67$, $SD=113.95$) conditions. Reading time measures from the Matrix Verb + 2 region also revealed no ME of verb ($F(1,39)=2.252$, $p=.141$), no ME of structure-type

(F(1,39)=1.498, p=.228), and no significant interaction (F(1,39)=.939, p=.338) across any of the four experimental conditions: Aspectual-SRC (M=401.10, SD= 112.83), Aspectual-ORC (M=421.09, SD=121.28), Psychological-SRC (M=396.76, SD=95.99), and Psychological-ORC (M=399.72, SD=99.27).

4.2.5 Target NP

Reading time measures from the Target NPs were also analyzed. Again, no statistically significant differences were observed between the Aspectual-SRC (M=419.56, SD=185.56), Aspectual-ORC (M=426.47, SD=163.52), Psychological-SRC (M=422.64, SD= 157.46), and Psychological -ORC (M=403.15, SD=141.32) conditions. There was no ME of verb-type (F(1,39)=.745, p=.393) and no ME of structure-type (F(1,39)=.760, p=.389). There was a marginal trend toward an interaction between verb-type and structure-type observed in this region (F(1,39)=3.595, p=.065), such that target NPs in the Psychological-ORC condition were read more quickly than in any of the other 3 conditions; however, this effect did not reach significance. Nevertheless, the trend is interesting as it shows a pattern opposite of that shown by the standard ORC-SRC asymmetry. This effect may have been driven by enhanced difficulty in the processing of SRCs where the target NP appears within the same clause as the selecting coercion verb.

4.2.6 Embedded Verb

Data from the Embedded Verbs were also submitted for analysis. Again, no statistically significant difference were found between the Aspectual-SRC (M=414.48, SD=122.80), Aspectual-ORC (M=422.46, SD=162.91), Psychological-SRC (M=418.83, SD= 141.18), and Psychological -ORC (M=455.24, SD=200.12) conditions. There was no ME of structure-type (F(1,39)= 2.339, p=.134), and no interaction between verb-type and structure-type (F(1,39)=2.116, p=.154) observed for this region; however, a marginal trend toward a ME of verb-type did emerge (F(1,39)= 3.496, p=.069), again not reaching significance.[3] This effect could have been driven by differences in the relative frequency of verbs across the

[3]Data from all regions discussed in this section were also analyzed with the data points corresponding to incorrect comprehension-question responses being removed (3.75% of the data). Again, no significant effects emerged at any of the relevant regions except in the Embedded Verb region where the trend toward a ME of verb strengthened (F(1,39)=3.857, p=.057), such that embedded verbs in the Aspectual-verb condition were read faster than those in the Psychological-verb condition, regardless of structure-type.

two verb classes, as mentioned in §4.1.3.1; however, such effects are not likely to persist, and thus do not explain the lack of ORC/SRC asymmetry observed at later regions (Matrix Verb, Matrix Verb +1, +2) (McElree et al. 2001; Traxler et al. 2002b).

4.3 Discussion

The results obtained in the present study are consistent with the findings of Lowder and Gordon (2015, 2016) in demonstrating that the magnitude of the coercion cost is reduced when the verb and complement NP appear in different clauses, as compared to when they are presented together within the same clause (Lowder & Gordon 2015, 2016). Contra the well-attested ORC/SRC asymmetry, evidence of difficulty emerged in the SRC condition where critical constituents appeared together within the same clause, relative to the ORC condition where the target NP appeared outside the embedded clause containing the coercing verb. The relative difficulty consistently associated with ORCs at the relative-clause and matrix verb regions was eliminated completely in the coercion environment, suggesting that indeed something about the within-clause composition of the coercion verbs and entity-denoting complements contributed to the increased difficulty observed in the SRC condition. The clausal separation offered by ORC constructions, on the other hand, appears to have modulated this effect. The findings that SRCs were just as difficult to process as ORCs at the initial coercion cue, matrix verb, and carry-over regions, regardless of which semantic class the coercing verb belonged to (Psychological or Aspectual), are consistent with previous experimental findings on complement coercion which indicate that (within-clause) coercive verb-complement relations are more difficult to process.

The experiment reported in this chapter also demonstrated that the modulating effect of clausal separation in complement coercion sentences held for both the Psychological and Aspectual verbs in the coercion verbs set. The fact that no differences were observed between the two verb groups at the critical regions suggests that the Psychological verbs used here and in previous studies do in fact demonstrate evidence of complement coercion. Like the aspectual-verb condition, the psychological-verb condition showed evidence of increased processing difficulty for SRCs at the critical regions, contra the standard ORC-SRC pattern.

The fact that uniform behavior was observed for the two verb groups investigated in this experiment adds support to the proclivity to treat the coercion verbs as a homogeneous set. However, it is of course still possible that these similar reading time measures for the two verb groups actually reflect different compositional processes. For one, given the difference in frequency observed for the two verb groups, noted in (1), the conclusiveness of these findings is limited by the possibility that the effects observed here—that is, the relative slow-down in SRCs as compared to control measures—are partially attributable to the fact that the verbs in the Psychological-verb condition had a relatively low frequency which caused a slow-down, while in the Aspectual-verb condition, what we are seeing is an actual coercion effect, or alternatively, the effect of dimension ambiguity resolution, as predicted by the SIH. Still, given that no slow-down occurred in the processing of ORCs in the Psychological-verb condition (as with the Aspectual-verb condition), it is less likely that the effects observed here were due to frequency effects.

Nevertheless, as an area for future research, the present study should be expanded to additionally compare reading times for these verb groups and structures, featuring eventive complements as well as entity-denoting complements. Recall that previous experimental findings suggest no evidence of a coercion cost when coercion verbs are combined with either verbal complements or event-denoting NP complements (Pickering et al. 2005; Traxler et al. 2002b). As such, expanding the present study to incorporate eventive complements, which are not predicted to engender a coercion cost, would allow for further exploration into potential differences between Psychological and Aspectual verbs in complement coercion contexts.

Likewise, while incorporating the use of SRC and ORCs into the design of the present experiment provided an avenue for investigating the interaction of syntactic and semantic complexity for both verb groups—an important area for research insofar as investigations into the strength of compositionality are concerned—there nevertheless remains a need for investigating potential differences in the behavior of these coercion verbs within simple sentences, using empirical means that do not suffer the same confounds as the studies reviewed in §3.2.

4.4 General discussion

The empirical findings and theoretical considerations presented here tentatively appear to favor a type-shifting account over the Structured Individual Hypothesis (SIH) in accounting for complement coercion phenomena. Reading time studies on complement coercion have consistently indicated that coercive sentences are costly to process. The fact that the processing cost emerges at, and just after, the critical NP is encountered is consistent with a type-shifting hypothesis, which predicts the detection of a type-mismatch, and subsequent type-shifting or enrichment operation, to occur at about this point in processing. Likewise, the neurolinguistic evidence discussed in §3.2 which found N400 amplitudes similar to those for animacy-violating and highly-implausible sentences is also compatible with a type-shifting hypothesis that relies on the detection of a selectional-violation.

On the other hand, the findings of Katsika et al. (2012) and Lai et al. (2014), which suggest that Psychological verbs previously used in complement coercion studies actually behave as controls, seem to offer support for the SIH, which treats aspectual verbs uniformly and excludes Psychological verbs from the so-called "coercion verbs" set, accrediting dimensional ambiguity for the processing cost. While this approach has the advantage of acknowledging the fact that Aspectual verbs select for scalar complements which are not necessarily eventive, assuming the computational cost observed is the result of ambiguity resolution does not explain the necessity of an eventive interpretation in complement coercion sentences, especially when they feature a psychological predicate. Likewise, reducing complement coercion to ambiguity resolution does not provide an explanation for the findings of Traxler et al. (2002) and Pickering et al. (2005), who show evidence that coercion verbs do not engender processing difficulty when combined with an eventive-NP complement (Traxler et al. 2002b) or with a verbal complement (Pickering et al. 2005)—evidence which the type-shifting hypothesis straightforwardly accounts for. Moreover, the findings of Frisson and McElree (2008) directly challenge theories that attribute the coercion cost to competition among possible interpretations, or to the need to select a single appropriate interpretation out of many, since no differences in the magnitude of the coercion cost were observed for strongly vs. weakly constrained interpretations (Frisson & McElree 2008).

The argument is not that ambiguity plays no role in the processing of complement

coercion constructions, but rather that previous experimental evidence on the processing of ambiguity, along with the findings of the present study, make it unlikely that this is all that happening. Indeed, investigations into the processing of lexical ambiguity have consistently shown that while lexical ambiguity can increase difficulty in processing, the effect only emerges when there is little difference in the frequency or meaning of an ambiguous term. For example, Reyner and Duffy (1986) used a self-paced reading paradigm to investigate the processing correlates of lexical ambiguity, finding that fixation times were longer only when the ambiguous words had two equally likely interpretations, but not when the ambiguous word had one highly likely meaning (either due to frequency or contextual constraints) (Rayner & Duffy 1986). Mason and Just (2007), using an ERP paradigm, similarly found evidence that different cortical regions were activated based on whether the ambiguous words had 'balanced' (two equally likely readings) versus 'biased' (one likely reading) interpretations (Mason & Just 2007). Thus, given the evidence put forth by Frisson and McElree (2008) that the magnitude of the coercion cost is not affected by competition among possible interpretations, it seems the processing cost associated with complement coercion cannot be reduced to ambiguity (Frisson & McElree 2008).

The findings of the present study are also at odds with the SIH since they clearly show that the Psychological verbs did not differ from the Aspectual verbs in engendering a processing cost at the critical regions. Conversely, the present results add support to type-shifting accounts, since on these accounts, both coercive Psychological and Aspectual verbs are treated as a homogeneous set with respect to the processing of complement coercion. This type of theory predicts a compositional operation of enrichment (Jackendoff 1997), or type-shifting (Pustejovsky 1991), which enables comprehenders to construe an eventive interpretation for the predicate-argument pair, taking place where, or shortly after, the coerced element has been encountered.

One question is why this effect should be dampened in certain syntactic environments. The explanation put forth by Lowder and Gordon (2016) suggests that while structural deemphasis itself does not seem to affect the magnitude of the coercion cost, structural separation of the critical constituents may have the effect of deemphasizing the relationship between them (Lowder & Gordon 2016). In the case of ORCs such as '*The memo that the secretary began announced…*,' for example, the target NP, '*the memo*,' holds two rela-

tionships: one to the embedded verb '*began*,' and one to the matrix verb '*announced*,' thus it is possible that comprehenders, or the language-comprehension system, due to finite resources, are prioritizing the main-clause relationship (where coercion does not apply), over the cross-clausal relationship (which may remain underspecified), while in the case of SRCs where the target NP enjoys only its relationship with the coercing verb, the coercion effect emerges (Lowder & Gordon 2015:535). In other words, perhaps the information contained within the embedded clause was being treated on a par with presupposition or background information to that expressed in the main clause, such that the relationship between the target NP and embedded verb attracted less attention from comprehenders as that between the target NP and matrix verb.[4] Importantly, the fact that coercion effects emerged in SRCs rules out the possibility that information contained within an embedded clause is generally processed at a shallower level (i.e., treated as presupposition rather than "at issue"; not given as much attention as main clause information, etc.). This suggests that the modulating effect of structural separation observed here and in previous work is driven by the fact that in ORCs, the target NP serves as the argument to both the matrix verb as well as the embedded verb, and thus, both relationship may not be given equal weight during the course of interpretation.

In any case, the findings of this work indicate that the relative difficulty of processing complex semantic expressions depends on the structure of the sentence in which they appear. Moreover, the work presented in this thesis demonstrates that the modulating effects of sentence structure holds for both Aspectual and Psychological verbs in the coercion verbs set. In both cases, SRCs, which present coercive elements together within the same clause, were at least as difficult to read as their ORC counterparts, despite the well-established observation that the ORCs are more difficult to process. The fact that the processing of ORCs was apparently not affected in the same way as that of the SRCs suggests that the processing difficulty associated with complement coercion is sensitive to the relationship between the coercing constituents and other elements in the sentence. Understanding what features coercive aspectual verbs have in common with coercive psycho-

[4]Such an explanation obviously disrespects strong compositionality as an inviolable property of natural language; however, given the evidence discussed in §2, it's not obvious the theory of semantic comprehension that ultimately bares out should adhere to strong compositionality.

logical verbs—that is, identifying which features appear to be relevant to the grammar—remains an important area for future research.

Still, type-shifting accounts cannot escape the need to account for the fact that aspectual verbs do not always obligatorily select for eventive arguments, and similarly do not always give rise to eventive interpretations. One way of achieving this might be to adopt a '*preference-based*' analysis of selectional restrictions, as proposed by Lowder and Gordon (2016), however such an amendment would obviously require additional machinery for determining an element's *preferred* selectional restrictions. Similarly, such an account is potentially challenged by findings that suggest the coercion effects are not modulated by contextual manipulations, nor by differences based on the "preferability" of sentences (as established via norming) (Frisson & McElree 2008).

CHAPTER 5

CONCLUSION

The present thesis has explored the principle of compositionality as it relates to natural language, looking specifically at phenomena that appear to challenge standard views of strong compositionality, such as complement coercion. I have explored various strongly and weakly compositional theoretical treatments of complement coercion that have been proposed in the literature, including both syntacticly and semantically oriented proposals. Two competing proposals were identified as being most promising for accounting for the phenomena of complement coercion—the Type-Shifting Hypothesis, and the Structured Individuals Hypothesis—each of which make different predictions regarding the behavior of distinct verb classes comprising the "coercion verbs" set. An experimental investigation into these competing predictions was conducted, and the results appear to favor the Type-Shifting Hypothesis, which predicts uniform behavior across the two verb-classes in question with regard to the processing of complement coercion phenomena.

In considering type-shifting approaches to complement coercion, two different proposals were reviewed: Pustejovsky's (1995) Generative Lexicon Theory (Pustejovsky 1995), and Jackendoff's (1997) theory of Enriched Composition (Jackendoff 1997). While these proposals are distinguishable on the basis of theoretical considerations, such as whether common-sense knowledge is assumed to be a part of our semantic understanding of a lexical item, the theories do not make different predictions that lend themselves obviously to empirical testing.

The study reported here was designed to specifically test whether both Psychological and Aspectual verbs identified in the coercion verbs set engender a similar processing cost in complement coercion contexts–a distinction which tests competing predictions of the SIH and the type-shifting approaches. As such, the present experiment does not speak to the comparative tenability of one type-shifting approach over the other, but it does put us

in a better position for exploring such considerations in the future.

Likewise, further research is necessary before the conclusiveness of the present findings can be established, namely more controlled experimental investigations into the modulating effects of sentence structure, which internally include a control group in their design. Likewise, further research into how these verb-classes behave across other structure-types featuring clausal boundaries is prudent if a better understanding of the modulating effects of sentence structure on complement coercion costs, as well as which lexical semantic properties of these verb classes are relevant for argument selection, is to be achieved. This also implies a need for further theoretical explorations into the roles decomposition and discourse context play in argument selection, composition, and the interpretive accommodation of arguments in coercive constructions.

APPENDIX

EXPERIMENTAL STIMULI

(1) a. The publisher that began the novel earned a great deal of money from advanced sales.
b. The novel that the publisher began earned a great deal of money from advanced sales.
c. The politician that resisted the bill earned nationwide support from Democratic voters.
d. The bill that the politician resisted earned nationwide support from Democratic voters.

(2) a. The editor that finished the newspaper received a Pulitzer Prize a couple of years ago.
b. The newspaper that the editor finished received a Pulitzer Prize a couple of years ago.
c. The lawyer that preferred the convertible attracted a lot of attention in the small town.
d. The convertible that the lawyer preferred attracted a lot of attention in the small town.

(3) a. The architect that finished the house included a large porch in the backyard that we all loved.
b. The house that the architect finished included a large porch in the backyard that we all loved.
c. The vacationer that enjoyed the pool warmed under the scorching heat of the afternoon sun.
d. The pool that the vacationer enjoyed warmed under the scorching heat of the afternoon sun.

(4) a. The farmer that started the fields produced corn, beans, and cucumbers later that year.
b. The fields that the farmer started produced corn, beans, and cucumbers later that year.
c. The tourist that enjoyed the wine arrived from a small town on the coast of California.
d. The wine that the tourist enjoyed arrived from a small town on the coast of California.

(5) a. The professor that finished the syllabus listed the dates of all the upcoming exams.
b. The syllabus that the professor finished listed the dates of all the upcoming exams.
c. The bartender that enjoyed the cigarette burned the old warehouse to the ground.
d. The cigarette that the bartender enjoyed burned the old warehouse to the ground.

(6) a. The auditor that began the taxes upset everyone at the firm.
b. The taxes that the auditor began upset everyone at the firm.
c. The athlete that endured the coach led the team to victory.
d. The coach that the athlete endured led the team to victory.

(7) a. The director that completed the script won the award for best screenplay.
b. The script that the director completed won the award for best screenplay.
c. The defendant that endured the lawyer made one final plea to the jury.
d. The lawyer that the defendant endured made one final plea to the jury.

(8) a. The woman that started the garden grew beautiful tulips and daffodils every spring.
b. The garden that the woman started grew beautiful tulips and daffodils every spring.
c. The dieter that resisted the cupcake sat in the foyer for the remainder of the party.
d. The cupcake that the dieter resisted sat in the foyer for the remainder of the party.

(9) a. The secretary that began the memo announced that there would be pay raises for all the employees.
b. The memo that the secretary began announced that there would be pay raises for all the employees.
c. The student that endured the textbook provided valuable insight into fixing the computer problems.
d. The textbook that the student endured provided valuable insight into fixing the computer prob-

lems.

(10) a. The engineer that completed the memo outlined the details of the upcoming fundraiser.
b. The memo that the engineer completed outlined the details of the upcoming fundraiser.
c. The volunteer that enjoyed the soup soothed the sick and elderly people in the hospital.
d. The soup that the volunteer enjoyed soothed the sick and elderly people in the hospital.

(11) a. The teenager that continued the novel recounted terrifying stories of zombies and vampires.
b. The novel that the teenager continued recounted terrifying stories of zombies and vampires.
c. The policeman that tolerated the uniform carried several extra weapons needed for the job.
d. The uniform that the policeman tolerated carried several extra weapons needed for the job.

(12) a. The waitress that started the coffee greeted the customers as soon as they walked in the diner.
b. The coffee that the waitress started greeted the customers as soon as they walked in the diner.
c. The surfer that endured the tuxedo received more complements than anyone had anticipated.
d. The tuxedo that the surfer endured received more complements than anyone had anticipated.

(13) a. The builder that completed the house included a stunning balcony in the master bedroom.
b. The house that the builder completed included a stunning balcony in the master bedroom.
c. The catcher that tolerated the fans accused the new pitcher of trying to sabotage the game.
d. The fans that the catcher tolerated accused the new pitcher of trying to sabotage the game.

(14) a. The publisher that continued the manuscript described the current state of our political system.
b. The manuscript that the publisher continued described the current state of our political system.
c. The protester that resisted the handcuffs presented a hassle for the policeman making the arrest.
d. The handcuffs that the protester resisted presented a hassle for the policeman making the arrest.

(15) a. The journalist that completed the article accused the governor of embezzling millions of dollars.
b. The article that the journalist completed accused the governor of embezzling millions of dollars.
c. The bridesmaid that tolerated the dress resembled an old potato sack covered in lace and bows.
d. The dress that the bridesmaid tolerated resembled an old potato sack covered in lace and bows.

(16) a. The stylist that started the braid reminded me of a new hairstyle I saw in a magazine last week.
b. The braid that the stylist started reminded me of a new hairstyle I saw in a magazine last week.
c. The infant that resisted the peas created an enormous mess for the new babysitter to clean up.
d. The peas that the infant resisted created an enormous mess for the new babysitter to clean up.

(17) a. The artist that continued the portrait illustrated many important techniques to the art students.
b. The portrait that the artist continued illustrated many important techniques to the art students.
c. The nurse that preferred the velvet fascinated many of the patients in the hospital on Sunday.
d. The velvet that the nurse preferred fascinated many of the patients in the hospital on Sunday.

(18) a. The editor that finished the article revealed that the senator was involved in a big scandal.
b. The article that the editor finished revealed that the senator was involved in a big scandal.
c. The pilot that preferred the biplane soared high above the snowy mountains this morning.
d. The biplane that the pilot preferred soared high above the snowy mountains this morning.

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